ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

EMI TEST RECEIVER

ESI7

1088.7490.07

ESI26

1088.7490.26

ESI40

1088.7490.40

CHAPTER 4 – INSTRUMENT FUNCTIONS

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Volume 1
Operating manual consists of 2 volumes

Printed in the Federal
Republic of Germany

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4 Instrument Functions

All functions of the EMI receiver are explained in detail in this chapter.

The instrument functions for general settings, printout and data management are described at the beginning of this chapter – key groups *SYSTEM*, *CONFIGURATION*, *HARDCOPY*, *MEMORY* and the *USER* key.

The sequence of the following key groups depends on their appearance on the front panel: key groups *FREQUENCY*, *LEVEL*, *MARKER*, *LINES*, *TRACE*, *SWEEP* and the *INPUT* key. The menus are described separately for the different operating modes.

Option Tracking Generator is described at the end of the chapter. Further options are supplied with a separate manual.

The various softkeys in a menu are described from top to bottom and from the left to the right side menu. The submenus are indicated by an indentation or displayed in a separate section. The whole path (key - softkey - ...) is indicated in the line above the menu display.

An overview of the menus is given in chapter 3 which also contains the description of the operating concept.

For fast reference a list of softkeys with the associated IEC/IEEE-bus commands is given at the end of Chapter 6.

An index at the end of the handbook provides as further help for the user.

General Configuration – *SYSTEM* and *CONFIGURATION* Key Groups

ESI Initial Configuration – *PRESET* Key

SYSTEM

PRESET CAL

DI AY INFO

Using the *PRESET* key, the ESI can be brought to a predefined initial state equivalent to the state after power on. All previous setting are deleted if they were not previously saved in memory. Returning to the *PRESET* state is not critical with regard to an arbitrary signal which may still be present at the input as long as the signal is within the specified voltage range.

Note: *The initial state set by the PRESET key can be adapted to the user requirements using the AUTO RECALL function. When the PRESET key is pressed, the AUTO RECALL dataset is loaded. For further information refer to Section "Saving and Recalling Data Sets".*

IEC/IEEE- bus command `:*RST`

Pressing the *PRESET* key, causes the ESI to enter its initial state according to the following table:

Table 4-1 Initial state of the ESI

Parameter	Setting
Mode	EMI Receiver
Receiver Frequency	100 MHz
RF Attenuation	Auto
Preamplification	off
Input	Input 1
Detector	AV
Measurement Time	100 ms
IF Bandwidth (RES BW)	120 kHz
Demodulation	off
Trigger	free run

Display Configuration – *DISPLAY Key*

The measurement results are displayed on the screen of the ESI either in a full-screen window or in two spli-screen windows. In some cases, the two windows can be subdivided into two diagrams each, e. g. for the representation of the inphase and quadrature signal in the vector analyzer mode (Option FSE-B7). In the EMI RECEIVER mode, a selection can be made in the upper half of the screen (SCREEN A) between bargraph display of receiver mode and the spectrum analyzer mode..

If only one window is used, this window fills the complete display screen. Two measurement windows are always placed over each other. The axes labelling and measurement settings are defined independently in each measurement window.

When two measurement windows are used, the settings can be chosen to be either coupled or fully independent from each other (depending on the operating mode). The measurement procedure is always sequential.

New instrument settings can only be entered in the active measurement window. This window is marked on the upper right corner of the grid. Coupled settings are changed simultaneously in both windows at the time of entry.

The entry of the measurement parameters for each of the two windows can be either independent from one another using numerical inputs, or by graphical definition of the span through the use of level and frequency lines. The former case, e.g., may be used for harmonic or frequency converter measurements, and the latter case, for a zoom display of a frequency or level segment.

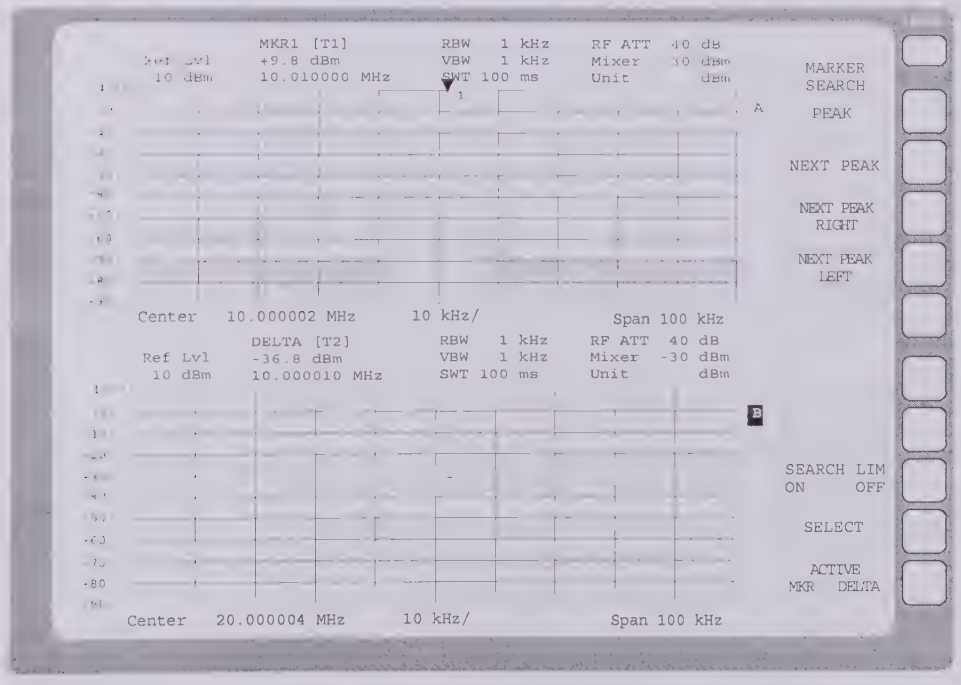
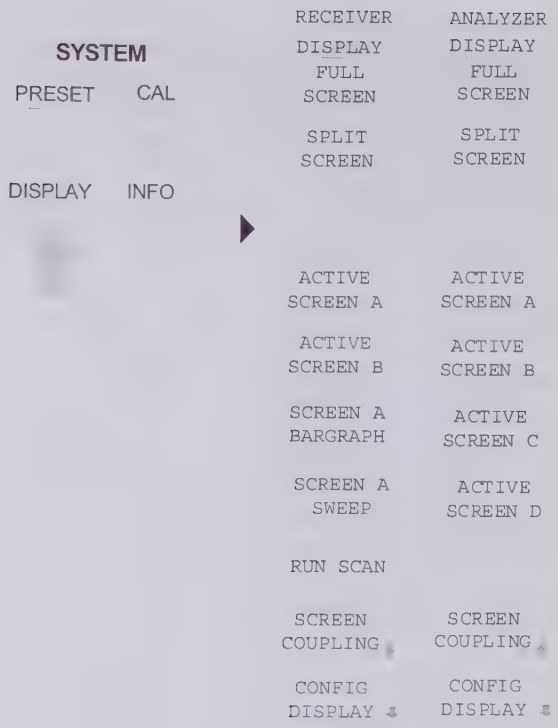


Fig. 4-1 Split screen mode

SYSTEM DISPLAY menu:



The *DISPLAY* key calls a menu which is used to configure the display screen and to select the active measurement window in SPLIT-SCREEN mode.

The menu differs for the two operating modes EMI RECEIVER and ANALYZER.

Display Screen Mode Selection

SYSTEM DISPLAY menu:

FULL SCREEN

The *FULL SCREEN* softkey selects the full-screen display.

In this mode, the *ACTIVE SCREEN A* / *ACTIVE SCREEN B* and *SCREEN COUPLING* softkeys are not used.

IEC/IEEE- bus command `:DISPlay:FORMat SINGle`

SPLIT SCREEN

The *SPLIT SCREEN* softkey selects the split screen mode. The upper screen is designated *SCREEN A*, the lower screen *SCREEN B*.

IEC/IEEE- bus command `:DISPlay:FORMat SPLit`
This is the default setting of the ESI.

EMI RECEIVER mode:

In the RECEIVER mode, a selection can be made in the upper half of the screen (SCREEN A) between bargraph display of receiver mode and the spectrum analyzer mode.
With spectrum analyzer selected, the scan display in the lower half of the screen remains unchanged and the spectrum analyzer with all its measurement functions is available in the upper screen half.
It is therefore possible to perform first a premeasurement with a scan and then to further investigate suspect signals with the aid of the spectrum analyzer, eg in the zero span to determine time characteristics. The center frequency of the spectrum analyzer can be coupled to the marker frequency of the scan display so that the frequencies to be analyzed can be easily displayed in the spectrum analyzer.

ACTIVE SCREEN A

If *SPLIT SCREEN* display is activated, the *ACTIVE SCREEN A* and *ACTIVE SCREEN B* softkeys activate either screen A or screen B.

The entry of new settings is only possible for the active window.

When switching back to *FULL SCREEN* mode, the active measurement window is displayed.

ACTIVE SCREEN A

These softkeys are only displayed if operation with two independent channels and different softkey menus - receiver with scan display and spectrum analyzer - is selected (*SCREEN A SWEEP*). Only in this case will it be necessary to assign entries to the receiver or to the spectrum analyzer.

IEC/IEEE bus command - (the screen is selected via the numeric suffix)

SCREEN A BARGRAPH

The *SCREEN A BARGRAPH* softkey switches on the bargraph measurement in the upper half of the screen (*SCREEN A*).

IEC/IEEE bus command `:INSTrument2[:SELect] RECeiver`

SCREEN A SWEEP

The *SCREEN A SWEEP* softkey switches on the analyzer mode in the upper half of the screen (SCREEN A).

The softkeys of all menus are assigned the analyzer functions. An exception is the *DISPLAY* menu where the *SCREEN A BARGRAPH* softkey is displayed to allow a return to the bargraph measurement.

IEC/IEEE bus command `:INSTrument[:SELect] SANalyzer`

RUN SCAN

The *RUN SCAN* softkey starts the frequency scan with the selected settings. (see Section "Frequency Scan").

ANALYZER mode:

ACTIVE SCREEN A

If *SPLIT SCREEN* display is activated, the *ACTIVE SCREEN A* and *ACTIVE SCREEN B* softkeys activate either screen A or screen B.

The entry of new settings is only possible for the active window.

When switching back to FULL SCREEN mode, the active measurement window is displayed.

ACTIVE SCREEN B

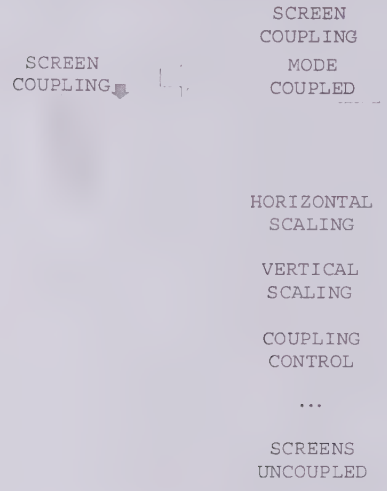
If, in addition, the two screens are both subdivided into two diagrams, the *ACTIVE SCREEN A/B* softkeys activate the upper diagram, *ACTIVE SCREEN C/D* the lower diagram in each screen.

IEC/IEEE- bus command - (the screen is selected via the numeric suffix)

Measurement Window Coupling

For the most part, the settings for the two windows can be either independently performed or coupled to one another. In many cases, when changes are made in one window (e.g., the reference level) it is desirable to also make the corresponding changes in the second window. The measurement window parameters which are to be coupled may be selected in the *SCREEN COUPLING* menu.

SYSTEM DISPLAY-SCREEN COUPLING submenu:



The *SCREEN COUPLING* softkey calls a sub-menu in which the coupling between the two measurement windows *SCREEN A* and *SCREEN B* can be defined. This coupling is only effective when both windows are displayed (*SPLIT SCREEN*).

In the default setting, all of the items which are selectable are also coupled.

MODE COUPLED

The *MODE COUPLED* softkey switches the coupling of the operating mode (Analyzer, Vector Analyzer) on/off.

IEC/IEEE- bus command `:INSTrument<1|2>:COUPle MODE`

HORIZONTAL SCALING

The *HORIZONTAL SCALING* softkey switches the coupled scaling of the horizontal axes on and off. In the frequency domain, the center frequency and the frequency span are identical. In the time domain, the sweep time for both windows is the same.

IEC/IEEE- bus command `:INSTrument<1|2>:COUPle X`

VERTICAL SCALING

The *VERTICAL SCALING* softkey switches the coupled scaling of the vertical axes on and off. For a level measurement, this means that the reference level and the vertical resolution (*LEVEL RANGE*) are set to the same values in both windows.

IEC/IEEE- bus command `: INSTrument<1|2>:COUPle Y`

COUPLING CONTROL

The *COUPLING CONTROL* softkey switches the coupling of the trigger and gate parameters and of SWEEP COUNT and SWEEP SINGLE/ CONTINOUS on/off.

IEC/IEEE- bus command `:INSTrument<1|2>:COUPle CONTrol`

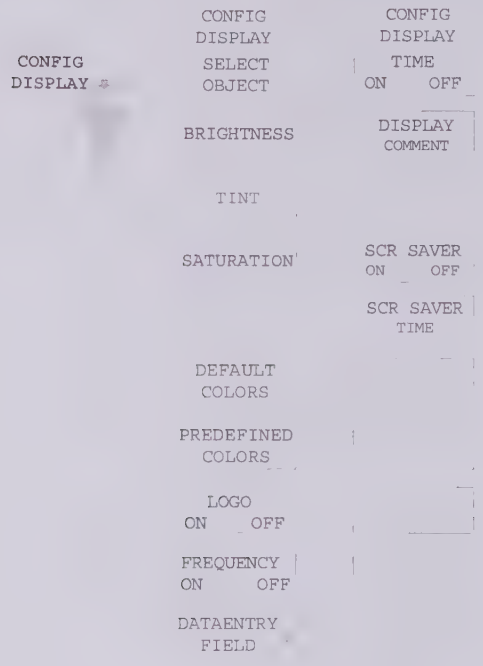
SCREENS UNCOUPLED

The *SCREENS UNCOUPLED* softkey switches all of the possible couplings between the measurement windows to off.

IEC/IEEE- bus command `: INSTrument<1|2>:COUPle NONE | ALL`

Display Screen Configuration

SYSTEM DISPLAY-CONFIG DISPLAY submenu:



The *CONFIG DISPLAY* softkey calls a submenu, in which the selection of color and brightness for the individual elements on the display screen takes place. The actual selection of the elements takes place in the corresponding menu table.

The color assignment of the softkeys is coupled with the color assignment of other display elements.

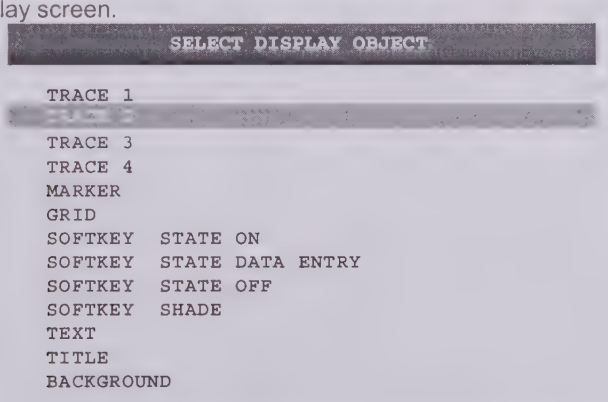
Changing for example the color of *SOFTKEY STATE OFF* causes the color of the table background to be changed at the same time. The same applies to SOFTKEY *STATE DATA ENTRY* and display lines, and to *SOFTKEY STATE ON* and enhancement labels.

In the right side menu, date, time and a diagram label can be displayed on the screen and the energy saving mode can be activated.

The *FREQUENCY ON/OFF* softkey is available only in analyzer mode.

SELECT OBJECT

The *SELECT OBJECT* softkey activates the *SELECT DISPLAY OBJECT* table, with which a graphics element can be selected. After selection, the brightness, tint and saturation of the selected element can be changed using the softkeys of the same name. The color changes can be seen immediately on the display screen.



BRIGHTNESS

The *BRIGHTNESS* softkey is used to enter the brightness of the color for the selected element. The range of input values is 0 to 100%.

IEC/IEEE- bus command `:DISPlay:CMAP:HSL <hue>,<sat>,<lum>`

TINT

The *TINT* softkey is used to enter the color tint of the selected element. The percentage that is entered specifies a point in a color spectrum ranging from red (0%) to blue (100%).
The *TINT* function is not available for monochrome (black/white) displays.

IEC/IEEE- bus command `:DISPlay:CMAP:HSL <hue>,<sat>,<lum>`

SATURATION

The *SATURATION* softkey is used to enter the color saturation of the selected element.
The range is 0 to 100%.

IEC/IEEE- bus command `:DISPlay:CMAP:HSL <hue>,<sat>,<lum>`

DEFAULT COLORS

The *DEFAULT COLORS* softkey restores the default settings for brightness, color tint and color saturation for all display screen elements.

IEC/IEEE- bus command `:DISPlay:CMAP<1...13>:DEFault`

PREDEFINED COLORS

The *PREDEFINED COLORS* softkey activates a table, to select the predefined colors for the diplay screen elements can be selected.

IEC/IEEE- bus command `:DISPlay:CMAP<1...13>:PDEFined BLACk`

LOGO ON OFF

The *LOGO* softkey switches the Rohde & Schwarz company logo displayed in the upper left corner of the display screen on or off.

IEC/IEEE- bus command `:DISPlay:LOGO ON | OFF`

FREQUENCY ON OFF

The *FREQUENCY* softkey switches the frequency information on the screen on and off. The softkey is available only in analyzer mode.

ON Frequency information is displayed.

OFF Frequency information is not output to the display. This can be used for example to protect confidential data.

IEC/IEEE- bus command `:DISPlay:ANNotation:FREQuency ON|OFF`

TIME ON OFF

The *TIME* softkey switches on or off the date and time display at the lower edge of the diagram.

IEC/IEEE- bus command `:DISPlay[:WINDow<1|2>]:TIME ON | OFF`

DISPLAY COMMENT

The *DISPLAY COMMENT* softkey activates the entry of a label comprising a maximum of 50 characters. This label is displayed at the lower edge of the diagram.
Pressing the softkey again causes the label to be switched off. The stored text, however, is not deleted.

IEC/IEEE- bus command

```
:DISPlay[:WINDow<1|2>]:TEXT[:DATA] <string>
:DISPlay[:WINDow<1|2>]:TEXT:STATe ON | OFF
```

SCR.SAVER ON OFF

The *SCR. SAVER* softkey is used to switch the energy saving mode for the display on/off.
After the elapse of the shutdown time (*SCR. SAVER TIME)* the display is completely switched off, ie including backlighting.
The screen saver is deactivated by pressing any key or by sending the corresponding IEEE/IEC/IEEE- bus command.

IEC/IEEE- bus command `:DISPlay:PSAVer[:STATe] ON | OFF`

SCR.SAVER TIME

The *SCR. SAVER TIME* softkey activates the entry of the time for the screen saver to respond. The shut-down time is entered in minutes between 1 to 100 minutes.

IEC/IEEE- bus command `:DISPlay:PSAVer:HOLDoff <num_value>`

SYSTEM DISPLAY-CONFIG DISPLAY DATAENTRY FIELD Untermenü:

The *DATAENTRY FIELD* softkey displays a submenu used to specify the position and characteristics of the data entry field.

IEC/IEEE- bus command - -

DATAENTRY X

The *DATAENTRY X* softkey shifts the position of the data entry field horizontally.

IEC/IEEE- bus command - -

DATAENTRY Y

The *DATAENTRY Y* softkey shifts the position of the data entry field vertically.

IEC/IEEE- bus command - -

DEFAULT POSITION

The *DEFAULT POSITION* softkey positions the data entry field automatically. In general, its position is the upper left edge of the grid on the active screen.

IEC/IEEE- bus command - -

DATAENTRY OPAQUE

The *DATAENTRY OPAQUE* softkey sets the data entry windows to opaque. This means that entry windows are underlayed with the background color for tables and that diagrams and traces behind an entry window can no longer be seen.

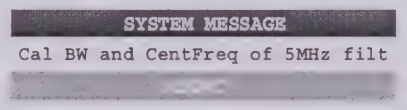
IEC/IEEE- bus command - -

Recording the Correction Data – *CAL Key*

The ESI maintains its high measurement accuracy thanks to its integrated system-error correction method. The *CAL* hard key provides a series of correction functions which allow not only the system error correction of the complete instrument, but also correction functions which are specifically applicable to the measurement requirements of relevant instrument sections.

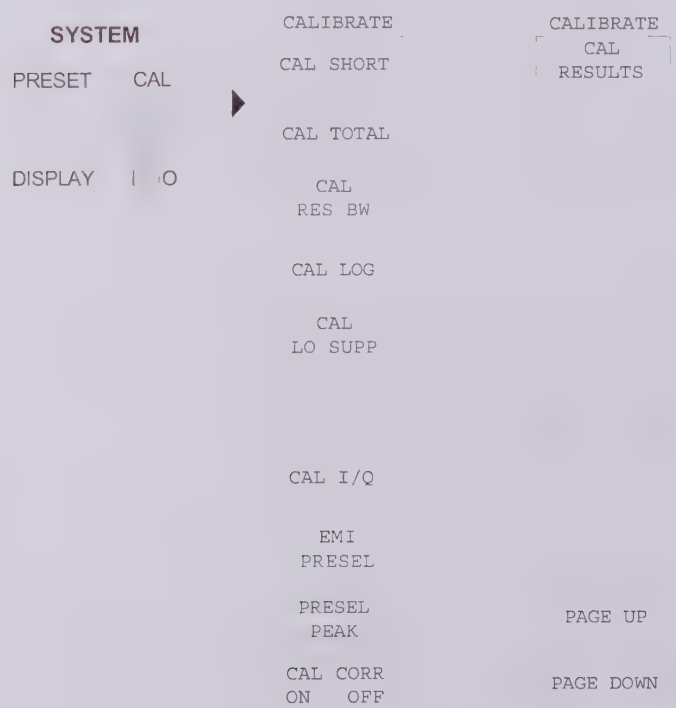
The measurement settings of the ESI are saved and, after system error correction, completely restored. The correction data valid before system error correction are saved and, in case of a correction abort, restored.

A window shows the progress of the correction data recording. *ABORT* can be used to abort the procedure at any time.



Note: *The term "Calibration" formerly used for integrated system error correction was often taken to be the "true" calibration of the instrument performed during production and service. It is, therefore, no longer used although it appears in abbreviated form in the name of keys ("CAL...").*

SYSTEM CAL menu:



The *CAL* key displays a menu with the system error correction functions.

Correction Function Calls

SYSTEM CAL menu:

CAL SHORT

The *CAL SHORT* softkey starts a short calibration, in which the absolute gain of the analyzer as well as the gain errors of the selected bandwidth are corrected.

IEC/IEEE- bus command `:CALibration:SHORt?`

CAL TOTAL

The *CAL TOTAL* softkey starts a complete correction of the receiver including additional partial corrections shown in the menu.

UNCAL is displayed in the status line if the correction data recording has failed or if the correction values are deactivated (*CAL CORR* softkey= *OFF*).

IEC/IEEE- bus command `:CALibration[:ALL]?`

CAL RES BW

The *CAL RES BW* softkey starts the correction of the center frequency, the bandwidth and the gain of the resolution filter.

IEC/IEEE- bus command `:CALibration:BANDwidth[:RESolution]?`

CAL LOG

The *CAL LOG* softkey starts the correction of the linearity of the logarithmic amplifier.

IEC/IEEE- bus command `:CALibration:LDETector?`

CAL LO SUPP

The *CAL LO SUPP* softkey starts the correction of the compensation of the first oscillator at low frequencies. After correction, the display of the internal oscillator at the frequency 0 Hz is very small.

It is recommended that the correction be performed whenever sensitive measurements are to be made at low frequencies.

CAL I/Q

The *CAL I/Q* softkey starts the correction of the gain error of the I/Q demodulator.
The softkey is only available in conjunction with option FSE-B7.

IEC/IEEE- bus command `:CALibration:IQ?`

EMI PRESEL

The *EMI PRESEL* soft key calibrates the frequency response of the preselector and the preamplifier.

IEC/IEEE- bus command `::CALibration:PRESelector?`

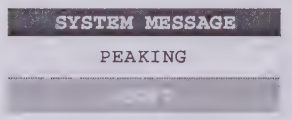
PRESEL PEAK

The *PRESEL PEAK* softkey optimizes the tuning of the preselector for input signals in the frequency range above 7 GHz.

This calibration should be used whenever signal levels in the frequency range above 7 GHz are to be measured and high accuracy is desired.

If a marker is not active when the *PRESEL PEAK* softkey is pressed, marker 1 is activated as the reference marker and placed on the signal maximum in the active trace. Otherwise the active marker is used.

The following window is displayed on the screen while the peaking function is running. The function can be aborted at any time using the *ABORT* line. In this case, the correction value determined at the factory is restored.



The input signal's signal-to-noise ratio must be at least 10dB in order that the peaking function runs properly. Otherwise, the preselector may be set incorrectly, which would cause level errors by subsequent measurements.

If the instrument setting (start/stop frequency, sweep time) is changed after *PRESEL PEAK* has been called, the correction value for the preselector determined by the function is no longer used. Instead, the correction value determined at the factory is restored.

IEC/IEEE- bus command `:CALibration:PPEak?`

CAL CORR ON OFF

The *CAL CORR ON/OFF* softkey switches the correction data on/off.

ON The status message depends upon the results of the total correction

OFF The message *UNCAL* appears in the ESI status line.

IEC/IEEE- bus command `:CALibration:STATe ON | OFF`

Results of System Error Correction

SYSTEM CAL menu:

CAL RESULTS

The *CAL RESULTS* softkey in the right-hand supplementary menu calls the *CALIBRATION RESULTS* table, which displays the correction data that has been recorded.

The *CALIBRATION RESULTS* table contains the following information:

page 1:

- date and time of the last recorded correction values
- overall results of the correction value recording
- list of the correction procedures according to function/module, including the correction values, the measured results and the individual results for each of the correction procedures

The results for the individual correction procedures are categorised and displayed as follows:

PASSED	system error correction was completely successful
CHECK	deviations larger than expected, however, corrections could be performed
FAILED	deviations too large, no corrections were possible
ABORTED	correction aborted

CALIBRATION RESULTS

```
CALIBRATION: PASSED
Last cal total: 05.Jun 1997 16:24:54

Calibration of IF Filters    PASSED
IF GAIN Adjust               PASSED
Bandwidth:
Filter   Cal Val [Hz] DAC Val State
  1kHz    2.806e+01    1679   PASSED
  2kHz    1.603e+01    2887   PASSED
  3kHz   -6.012e+00    3238   PASSED
  5kHz   -1.002e+01    3514   PASSED
 10kHz    1.804e+02    3703   PASSED
 20kHz    3.607e+02    3801   PASSED
 30kHz    8.417e+02    3831   PASSED
 50kHz    1.403e+03    3743   PASSED
100kHz    1.804e+03    3698   PASSED
200kHz    3.607e+03    3606   PASSED
300kHz    8.417e+03    3516   PASSED
500kHz    1.403e+04    3329   PASSED
  1MHz    2.806e+04    2881   PASSED
```

IEC/IEEE- bus command - -

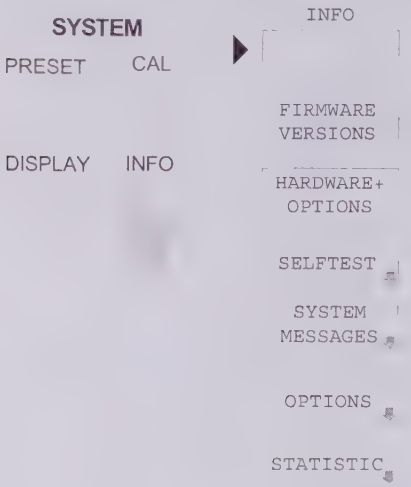
PAGE UP

PAGE DOWN

The *PAGE UP* and *PAGE DOWN* softkeys can be used to page through the table of correction results.

Instrument Status and Measurement Parameters – INFO Key

SYSTEM INFO menu:



The *INFO* key is used to request general information concerning the instrument. These include:

- firmware version
- installed hardware and hardware options
- modification level of the individual modules
- self-test results with the option of calling self-test functions
- list of generated system messages
- installed firmware and hardware options.
- Statistical evaluations

Firmware Versions

SYSTEM INFO menu:

FIRMWARE VERSION

The *FIRMWARE VERSIONS* softkey opens two tables, which provide the following informations:

- Table *MODEL* displays the exact instrument model.

MODEL
ESI26

- In the FIRMWARE VERSION table, the version of each software component installed in the instrument is listed. The versions of programmable logic devices are also included if the firmware version of the device can be determined.

FIRMWARE VERSION	
BIOS	1.2
RECEIVER	1.65
SERIAL NUMBER	101379/005

IEC/IEEE- bus command `:*IDN?`

Hardware Configuration and Options

SYSTEM INFO menu:

HARDWARE+ OPTION

The *HARDWARE+OPTIONS* softkey opens two tables in which the modules (INSTALLED COMPONENTS) installed in the instrument are listed.

- Table *MODEL* lists the instrument name and model:

MODEL
ESI26

- Table *INSTALLED COMPONENTS* consists of four columns:

  COMPONENT name of module

  MODEL INDEX model number of the module

  MODIF INDEX main modification index of the module

  HW CODE secondary modification index of the module

  These lists contain only the modules which are actually present in the instrument, i.e., the modules which were identified by the module recognition software.

INSTALLED COMPONENTS			
COMPONENT	MODEL INDEX	MODIF INDEX	HW CODE
Main Processor	4	n/a	0
Graphic Board	4	n/a	0
I/O Board	4	n/a	0
FRAC SYN	4	0	4
RF Module	4	0	4
2nd IF Converter	3	2	2
LO Phase	3	4	12
Preselector	2	6	0
MW Converter	2	0	0
MW YIG Filter	2	0	0
Detector	4	0	2
RF Attenuator	4	4	0
IF Filter	3	2	3
Digital IF	2	0	2

IEC/IEEE- bus command `*OPT?`
`:SYSTem:BINFo?`

OPTIONS

The *OPTIONS* softkey opens two tables listing the options installed. The standard ESI is equipped with options FSE-B4 and FSE-B5. The options are indicated for reasons of compatibility to instrument family FSE.

FIRMWARE OPTIONS		
DESIGNATION	TYPE	CODE
FFT	B5	1938496289

Note: *New firmware options can be enabled in the SETUP menu.*

HARDWARE OPTIONS	
DESIGNATION	CODE
Low Phase Noise & OCXO	B4
Vector Signal Analysis	B7

IEC/IEEE- bus command `*OPT?`

Self Test

SYSTEM INFO-SELFTEST submenu:

SELFTEST ▶ SELFTEST / EXECUTE TESTS / . . .

The *SELFTEST* softkey opens a submenu with which the self test can be started.

The instrument has extensive self test functions which comprehensively test instrument functionality. In case of a fault, the instrument can locate a defective module on its own. The self test sequence is described in more detail in the service manual instrument (supplied with the ESI).

EXECUTE TESTS

The *EXECUTE TESTS* softkey starts the test of the complete instrument. During the self test a window is displayed:

The functions are tested in the following order:

1. Modules main CPU, digital motherboard, graphics and the interfaces
2. Reference frequency conditioning, the synthesizer modules and all LO signals
3. All RF, IF and signal-weighting modules

If no failure occurs during the execution of the self test, the following message is displayed when the complete self test is finished:

If a failure occurs during the execution of the self test, the self test is immediately aborted and a message indicating the defective module and the defective function is displayed:

Further testing should be performed by an R&S service department.

IEC/IEEE- bus command : *TST?

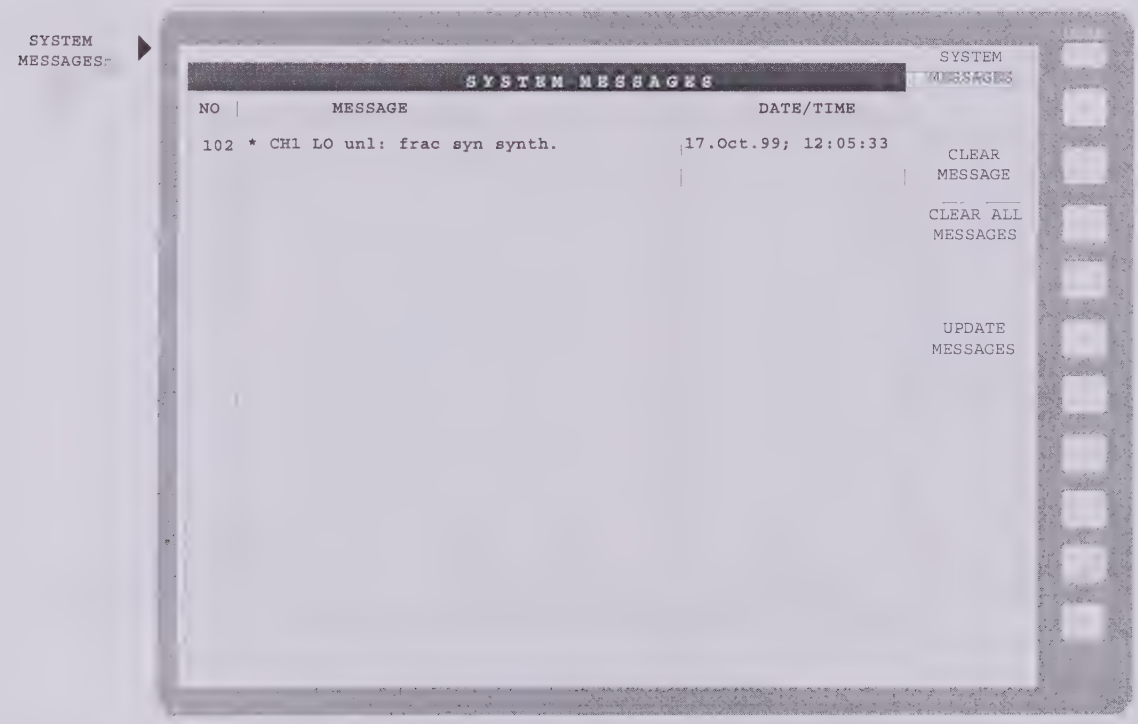
System Messages

The *SYSTEM MESSAGES* softkey opens a submenu with a table in which the generated system messages are displayed. The most recent messages are at the top of the list.
The following information is presented:

NO	Device-specific three-digit error code (shown as XXX in the figure)
MESSAGE	Brief description of the reason for the message
DATE/TIME	Date and time of the message

Error messages that have occurred since the *SYSTEM MESSAGES* menu was last called are marked by an asterix "*".

SYSTEM INFO-SYSTEM MESSAGES submenu:



IEC/IEEE- bus command `:SYSTem:ERRor?`

CLEAR MESSAGE

The *CLEAR MESSAGE* softkey deletes the message just selected.
All subsequent messages are shifted automatically one line upwards so that no empty lines exist. When the last message has been deleted, the selection bar also disappears.

IEC/IEEE- bus command `:SYSTem:ERRor?`

CLEAR ALL MESSAGES

The *CLEAR ALL MESSAGES* softkey deletes all messages.

IEC/IEEE- bus command - -

UPDATE MESSAGES

The *UPDATE MESSAGES* softkey causes all newly arrived messages to be entered at the top of the table. At this time, all messages previously indicated as "new" are displayed as "old" messages

IEC/IEEE- bus command - -

Statistics Function for Input Attenuator Switching

SYSTEM INFO menu:

STATISTIC — STATISTICS | ATT SWITCHES

The *STATISTICS* softkey calls a submenu for indication of device statistics.

ATTEN SWITCHES

The *ATT SWITCHES* softkey displays various tables listing the mechanical switches and attenuators fitted in the instrument, plus the number of switching operations for the respective switch or attenuator.

INPUT ATTENUATOR	
Date	5 Aug 1999
Calibration Input	6
10 dB	121
20 dB	217
30 dB	137

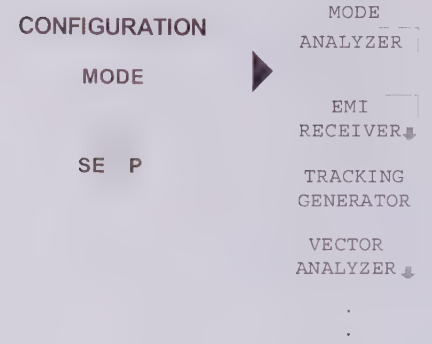
IEC/IEEE- bus command

```
:DIAGnostic:INFO:CCOunt:ATTenuation<1|3>
```

Mode Selection – *MODE* Key

The ESI can be operated in one of several modes, each of which is different with respect to functionality and control. The differences in control, however, consist not only in the enabling/disabling of additional softkeys within existing softkey menus, but rather in the fact that existing menus are completely replaced by new menus and menu trees which are tailored to the functional requirements.

CONFIGURATION MODE menu



The *MODE* key opens the menu for selection of the mode.

Herein, the modes can be selected according to the available ESI options.

- Analyzer
- EMI Test Receiver
- Tracking Generator
- Vector Signal Analysis

ANALYZER

The *ANALYZER* softkey selects the *ANALYZER* mode.

The functions provided correspond to those of a conventional spectrum analyzer. The analyzer measures the frequency spectrum of the test signal over the selected frequency range with the selected resolution and sweep time, or, for a fixed frequency, displays the waveform of the video signal.

IEC/IEEE-bus command `:INSTrument[:SELect] SANalyzer`

EMI RECEIVER

The *EMI RECEIVER* softkey selects the *EMI Test Receiver* mode.

This mode is the default setting of the ESI.

In the receiver mode, ESI behaves like a test receiver, ie if the basic settings are active, it measures the level with the selected bandwidth and measurement time at the set frequency. The signal is evaluated by means of the four detectors average, peak, rms and quasi peak.
A frequency sweep may be carried out with the start and stop frequencies and the stepwidth.

The main menu of the *RECEIVER* mode is described in detail in Section 'EMI Receiver Mode'.

IEC/IEEE-bus command `:INSTrument[:SELect] RECeiver`

TRACKING GENERATOR

The *TRACKING GENERATOR* softkey selects the operating mode Scalar Network Analysis.
The softkey is only available if ESI is equipped with option: FSE-B10 or B11.
For a detailed description of operation see Section 'Option Tracking Generator'.

VECTOR ANALYZER

Softkey *VECTOR ANALYZER* selects the vector analysis mode.

The softkey is only available if ESI is equipped with Option FSE-B7.

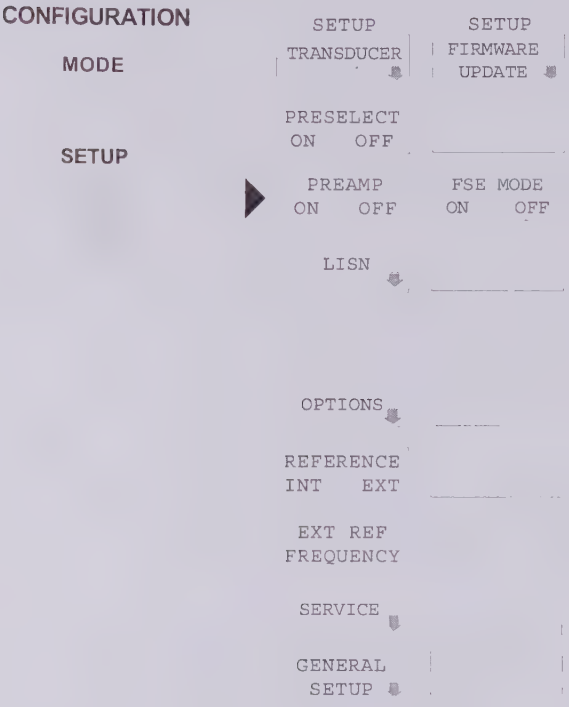
In the vector analyzer mode the ESI is automatically set to a fixed frequency (center frequency) since vector analysis can only be carried out on one frequency.
The IF signal is digitized by the selected resolution bandwidth after filtering and mixed into the baseband by a digital mixer. Further processing is via digital signal processors which display the time characteristic of the amplitude or phase. As an option, the baseband can also be demodulated and the demodulated signal can be displayed. Principally any type of modulation (digital and analog) can be processed.

The functions of the analyzer mode are supplemented by the vector analysis functions which are described in detail in a separate manual to the option.

IEC/IEEE-bus command `:INSTrument[:SELect] DDEMod`

Preliminary Setup and Interface Configuration – *SETUP* Key

CONFIGURATION SETUP menu:



The *SETUP* key opens the menu for configuration of the ESI.

The *TRANSDUCER* softkey opens a submenu for entering correction characteristics for the measurement transducer.

Softkey *PRESELECT* activates the preselection in the Analyzer mode.

Softkey *PREAMP* switches the preamplifier on and off while preselection is active.

The *LISN* softkey opens the submenu including the settings required to control V-networks (LISNs).

The *OPTIONS* softkey allows the enabling of firmware options (Application Firmware Modules).

The *REFERENCE INT/EXT* and *EXTERNAL REF FREQUENCY* softkeys determine the reference to be used.

The *SERVICE* softkey provides special setup functions which, although not necessary in normal use, are useful in instrument service.

The *GENERAL SETUP* softkey opens a submenu for all the general settings such as date and time as well as the configuration of the device interfaces.

The *FIRMWARE UPDATE* softkey opens a submenu for the installation of a firmeware update.

The *FSE MODE* softkey determines whether the ESI is FSE-compatible after preset.

Using Transducers

A transducer is often connected ahead of ESI both during the measurement of useful signals and EMI and converts the useful or interference variable such as field strength, current or RFI voltage into a voltage across 50 Ohm. Transducers with a frequency-independent transducer factor can be coded in 10-dB steps together with the unit at connector *PROBE CODE*. They are supplied at the same time by this connector. Transducers such as antennas, probes or current probes mostly have a frequency-dependent transducer factor which can be stored in ESI and automatically has the correct unit during level measurement.

If a transducer is switched on it is considered as part of the unit during the measurement, ie the measured values are displayed in the correct unit and magnitude. When working with two measurement windows, the transducer is always assigned to two windows.

ESI distinguishes between **transducer factor** and **transducer set**. A transducer factor takes the frequency response of a single transfer element, eg an antenna into consideration. A transducer set can summarize different transducer factors in several subranges (several transducer factors at the same time), eg an antenna, a cable and a diplexer.

A transducer factor consists of max. 50 reference values defined with frequency, transducer factor and the unit. For the measurement between frequency values linear or logarithmic interpolation of the transducer factor can be chosen.
Several factors can be compiled in a transducer set provided that all factors have the same unit or unit "dB". The frequency range covered by a set can be subdivided into max. 10 subranges (each with up to 4 transducer factors) which follow each other without a gap, ie the stop frequency of a subrange is the start frequency of the next subrange.

The transducer factors used in a subrange have to fully cover the subrange.

The definition of a transducer set is recommended if different transducers are used in the frequency range to be measured or if a cable attenuation or an amplifier has to be taken into consideration.

If a transducer set is defined during a frequency sweep, the latter can be stopped at the interface between two transducer ranges and the user is asked to exchange the transducer.
The following message informs the user that the limit has been reached:

TDS Range # reached, CONTINUE / BREAK

He can continue the sweep by confirming the message (*CONTINUE*) or he can switch off the transducer (*BREAK*).

With the automatic switchover of the transducer used, the frequency sweep is not interrupted.

Note: *Transducers cannot be used in vector analyzer mode.*

Activating Transducer Factors and Transducer Sets

The *TRANSDUCER* softkey opens a submenu in which already defined transducer factors or sets can be activated or deactivated, new transducer factors or sets can be generated or existing transducer factors or sets can be edited. Tables with the defined transducer factors and sets are displayed. The table (factor or set) in which a transducer is active is set.

By switching on the transducers all the level settings and outputs are automatically made in the unit of the transducer. A change of the unit in menu *LEVEL REF* is no longer possible as ESI together with the transducer used is regarded as a measuring instrument. Only if the transducer has the unit dB, can the original unit at ESI be maintained and changed.

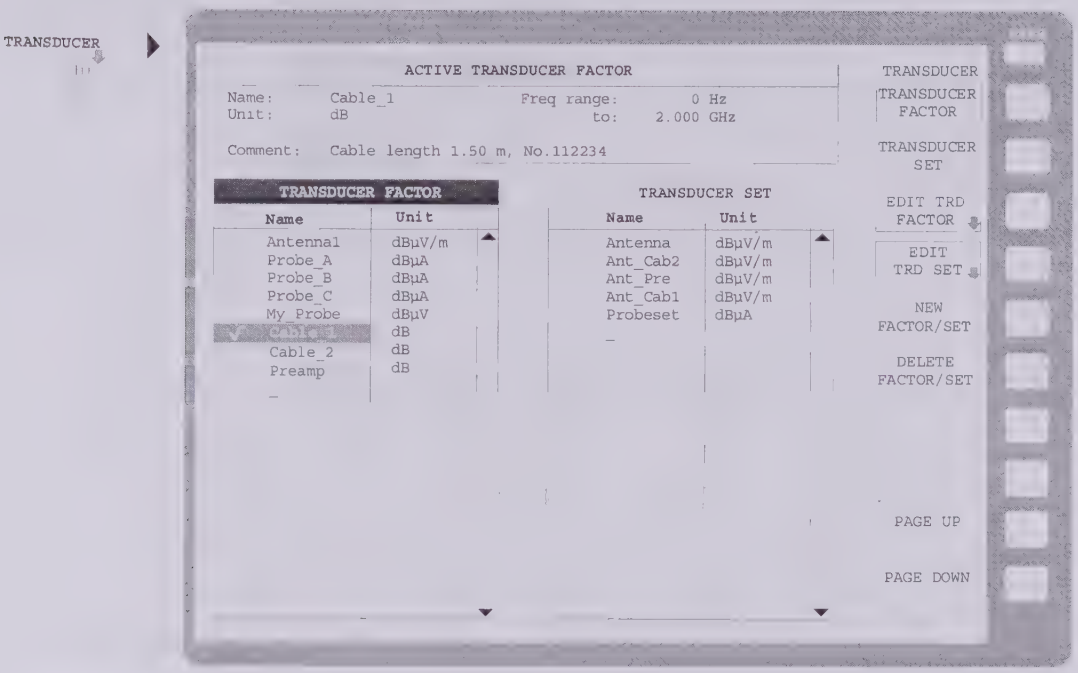
Note: *If one of the units dBµV, dBµV/m, dBµA, or dBµA/m is selected, the LEVEL REF key (see UNIT-submenu) can be used to switch to the corresponding units referred to the bandwidth, i.e. dBµV/MHz, dBµV/mMHz, dBµA/MHz, dBµA/mMH.*

If a transducer factor is active, TDF is displayed in the column of the enhancement labels and TDS if the transducer set is active.
After switching off all the transducers, ESI continues to use the unit which was selected before a transducer was switched on.

In the analyzer mode, an active transducer for a sweep is uniquely calculated for each point displayed after its setting and added to the result of the level measurement during the sweep. If the sweep range is changed, the correction values are recalculated. If several measured values are combined, only a single value is taken into consideration.

If an active transducer factor/set is not defined over the whole sweep or scan range during the measurement, the missing values are replaced by zero.

CONFIGURATION SETUP Menu



The upper table *ACTIVE TRANSDUCER FACTOR / SET* indicates the active transducer factor or the set with the associated name, frequency range and unit. If no factor or set is active, *none* is displayed in the table. Additional information can be entered in a comment line. If a transducer factor is active, the selected interpolation is displayed in addition, if a set is active, the break setting is displayed.

The left table *TRANSDUCER FACTOR* comprises all the defined factors with name and unit. If the number of defined transducer factors exceeds the number of possible lines in the table, the table will be scrolled.

The right table *TRANSDUCER SET* comprises all the defined transducer sets with the corresponding information.

Only one set or transducer can be activated. An already active transducer factor or set is switched off automatically if another one is switched on. An activated transducer factor or set is marked with a check sign.

TRANSDUCER FACTOR

The *TRANSDUCER FACTOR* softkey sets the selection bar to the position of the active transducer factor.
If no transducer factor is switched on, the bar is positioned to the first line of the table.

IEC/IEEE bus commands

```
:[SENSe<1|2>:]CORRection:TRANsducer:SELect <name>
:[SENSe<1|2>:]CORRection:TRANsducer[:STATe] ON | OFF
```

TRANSDUCER SET

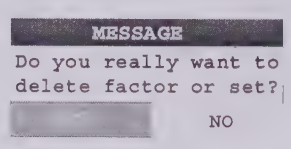
The *TRANSDUCER SET* softkey sets the selection bar to the position of the active transducer set.
If no transducer set is switched on, the bar is set to the first line of the table.

IEC/IEEE bus commands

```
:[SENSe<1|2>:]CORRection:TSET:SELect <name>
:[SENSe<1|2>:]CORRection:TSET[:STATe] ON|OFF
```

DELETE FACTOR/SET

The *DELETE FACTOR/SET* softkey deletes the marked factor or set. To avoid deletion by mistake, deletion has to be confirmed.



IEC/IEEE-bus command

```
:[SENSe<1|2>:]CORRection:TRANsducer:DELete
:[SENSe<1|2>:]CORRection:TSET:DELete
```

PAGE UP

PAGE DOWN

The *PAGE UP* and *PAGE DOWN* softkeys are used to scroll in large tables which cannot fully be displayed on the screen.

New Entry and Editing of Transducer Factors

A transducer factor is characterized by

- reference values with frequency and transducer factor (*Values*)
- the unit of the transducer factor (*Unit*) and
- the name (*Name*) to distinguish between the different factors.

During the entry, ESI checks the transducer factor according to specific rules that have to be met to ensure trouble-free operation.

- The frequencies for the reference values always have to be entered in ascending order. Otherwise, the entry is not accepted and the following message is displayed:

  Frequency Sequence!

- The entered frequencies do not necessarily have to be set at ESI, as only the values for the frequency display range are considered for a set sweep or scan. The minimum frequency for a reference value is 0 Hz, the maximum frequency 200 GHz.

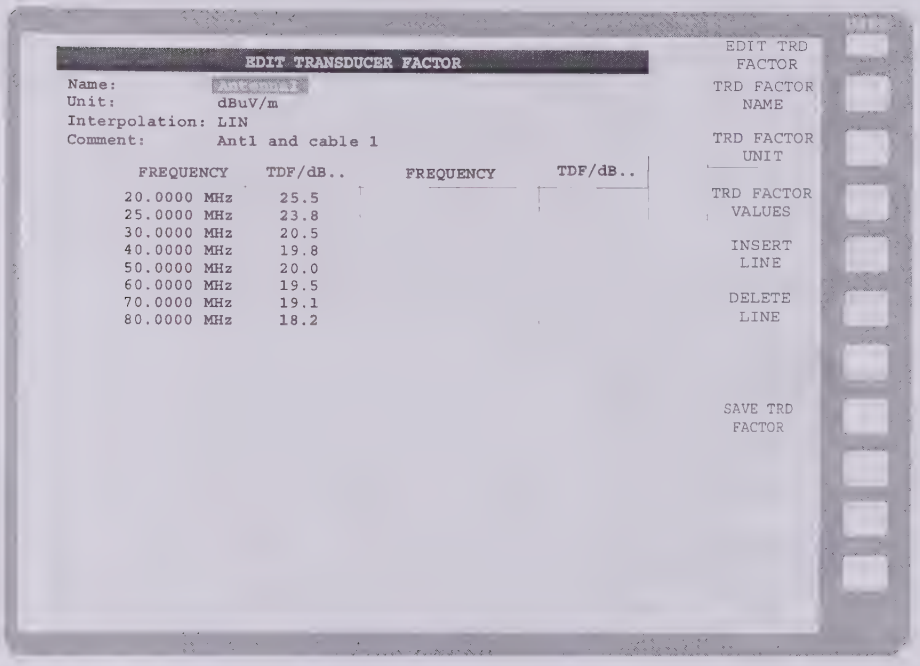
- The minimum or maximum value for a transducer factor is -200 dB or 200 dB. The unit "dB" means that the transducer factor is always logarithmic and has nothing to do with the physical transducer factor, which, for example, establishes the relationship between field strength and voltage into 50 Ohm. If the minimum or maximum value is exceeded, ESI signals:

  Min Level -200 dB or
  Max Level 200 dB.

- Amplifiers have a negative transducer factor, attenuation values have to be entered as a positive transducer factor.

Note: *A unit activated by switching on the transducer has priority over a coded unit of the connected probe.*
With the exception of dB/MHz, the softkeys for the unit in the menu under key LEVEL REF are inoperative with the transducer switched on.*

The *EDIT TRD FACTOR* and *NEW FACT/SET* softkeys both open the submenu for editing and entering new transducer factors. A precondition for the *NEW FACTOR/SET* softkey is that the selection bar is located in the table when the table *TRANSDUCER FACTOR* is called up.



The table with the data of the marked factor (the *EDIT TRD FACTOR* softkey) or an empty table is displayed in which the following entries are preset (the *NEW FACTOR/SET* softkey):

Unit: dB

Interpolation: LIN for linear frequency scaling
LOG for logarithmic frequency scaling

The characteristics of the factor can be entered in the header field of the table, the frequency and the transducer factor in the columns of the table.

Name Entry of the name

Unit Selection of unit

Interpolation Selection of interpolation

Comment Entry of a comment

FREQUENCY Entry of the frequency of the reference points

TDF/dB Entry of the transducer factor.

An overwritten transducer factor remains stored in the background as long as the edited factor is stored with the *SAVE TRD FACTOR* softkey or until the table is closed. A factor overwritten by mistake can be restored by leaving the entry.

TRD FACTOR NAME

The *TRD FACTOR NAME* softkey activates the entry of the transducer factor characteristics in the header field of the table.

***Name* - Entry of name**

A maximum of 8 characters is permissible for the name. The characters have to comply with the convention of DOS file names. The unit automatically stores all transducer factors with the extension .TDS.

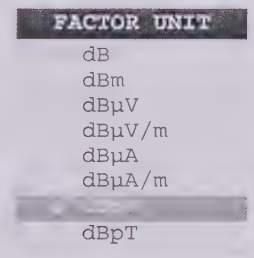
If an existing name is changed, the factor stored under the previous name is retained and will not be overwritten automatically with the new name. The previous factor can be deleted at a later time, using *DELETE FACTOR/SET*. Thus, factors can be copied.

IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TRAN:SELect <name>`

TRD FACTOR UNIT

***Unit* - Selection of unit**

The unit of the transducer factor is selected from a selection box activated by the *TRD FACTOR UNIT* softkey.



The default setting is dB.

IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TRAN:UNIT <string>`

***Interpolation* - Selection of interpolation**

Linear or logarithmic interpolation can be carried out between the frequency reference points of the table. Selection is via the ENTER key which is toggled between LIN and LOG (toggle function).

The following diagrams indicate the effect of the interpolation on the calculated characteristic:

IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TRAN:SCAL LIN|LOG`

Fig. 4-2 Linear frequency axis and linear interpolation

Fig. 4-3 Logarithmic frequency axis and logarithmic interpolation

Fig. 4-4 Logarithmic frequency axis and linear interpolation

***Comment* - Entry of a comment**

The comment can be freely selected. It can have a maximum number of 50 characters.

IEC/IEEE-bus command `:[SENS<1|2>:]CORR:TRAN:COMM <string>`

TRD FACTOR VALUES

The *TRD FACTOR VALUES* softkey activates the entry for the reference values of the transducer factor.

The selection bar marks the first reference value. The desired reference values have to be entered in ascending frequency sequence.
After entering the frequency the selection bar automatically jumps to the corresponding level value. After entering the first reference value the table can be edited. The two *INSERT LINE* and *DELETE LINE* softkeys are displayed. Individual values are changed at a later time by marking the field and by entering the new value.

IEC/IEEE-bus command `:[SENS<1|2>:]CORR:TRAN:DATA <freq>,<level>`

INSERT LINE

The *INSERT LINE* softkey inserts a free line above the marked reference value. When entering a new reference value into this line watch out for the ascending frequency sequence.

DELETE LINE

The *DELETE LINE* softkey deletes the marked reference value (the whole line). The following reference values move up.

IEC/IEEE-bus command `--`

SAVE TRD FACTOR

The *SAVE TRD FACTOR* softkey saves the changed table in a file on the internal hard disk.

If a transducer factor with the same name already exists, a corresponding query is performed beforehand.
If the factor to be newly saved is currently switched on, the new values will immediately be valid. If a transducer set is switched on comprising the factor, the values will only be used when the set is switched on next time.

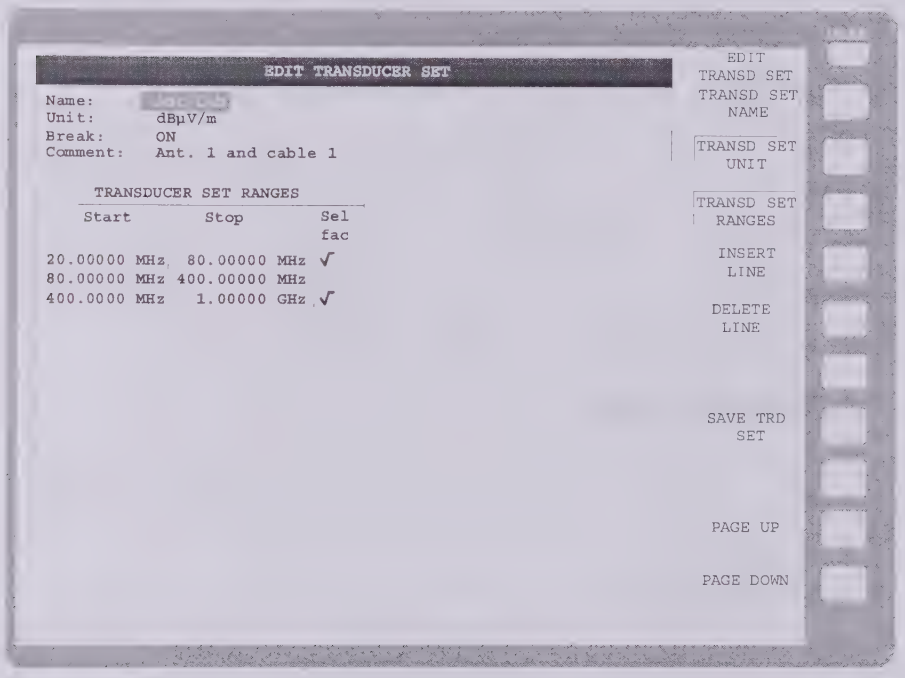
IEC/IEEE-bus command - (executed automatically)

New Entry and Editing of Transducer Sets

A transducer set is characterized by:
- maximum 10 ranges (*Ranges*) in which different transducer factors can be active
- the combination of several transducer factors per range (*Factor*)
- a transducer-set name *(Name)*

EDIT TRD SET	NEW TRD FACTOR/SET

The *EDIT TRD SET* and *NEW FACTOR/SET* softkeys both open the submenu for editing and entering new transducer factors. A precondition for the *NEW FACTOR/SET* softkey is that the selection bar is located in the table *TRANSDUCER SET*.



The table with the data of the marked set (the *EDIT TRD SET* softkey) or an empty table in which the following entries are preset (the *NEW FACTOR/SET* softkey) is displayed:

Unit: dB
Break: NO

The characteristics of the set can be entered in the header field of the table, the subranges in the columns of the set.

Name	Entry of the name
Unit	Selection of unit
Break	Activating the query when changing the subrange
Comment	Entry of a comment
Start	Entry of the start frequency of the subrange
Stop	Entry of the stop frequency of the subrange
Sel Fac	Selection of the transducer factors for the subrange

An overwritten transducer set remains stored in the background as long as the edited factor is stored with the *SAVE TRD SET* softkey or until the table is closed. A set overwritten by mistake can be restored by leaving the entry.

TRANSD SET NAME

The *TRD SET NAME* softkey activates the entry of the transducer set characteristics in the header field of the table.

***Name* - Entry of name**

A maximum of 8 characters is permissible for the name. The characters have to comply with the convention of DOS file names. The unit automatically stores all transducer sets with the extension .TDS.

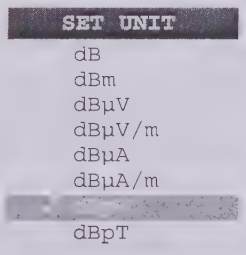
If an existing name is changed, the set stored under the previous name is retained and will not be overwritten automatically with the new name. The previous set can be deleted at a later time using *DELETE FACTOR/SET*. Thus, sets can be copied.

IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TSET:SELect <name>`

TRANSD SET UNIT

***Unit* - Selection of unit**

The unit of the transducer set is selected from a selection box activated by the *TRANSD SET UNIT* softkey.
The unit should be selected prior to the entry as it determines the settable transducer factors. The preset unit for new sets is "dB". The unit can no longer be changed when editing a set as the set of selected transducer factors will otherwise become inconsistent.



IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TSET:UNIT <string>`

***Break* - Activation of query when changing a subrange**

The sweep can be stopped if the user changes the subrange and selects a new subrange of the transducer. A message informs the user that the limit has been attained. He can continue the sweep or switch off the transducer.
The interruption is activated by setting Break to ON. Selection is by the ENTER key which toggles between ON and OFF (toggle function).

IEC/IEEE-bus command `:[SENSe<1|2>:]CORR:TSET:BREak ON|OFF`

***Comment* - Entry of a comment**

The comment can be freely selected. It can have a maximum number of 50 characters.

IEC/IEEE-bus command
`:[SENSe<1|2>:]CORR:TSET:COMMent <string>`

TRANSD SET RANGES

Softkey *TRANSD SET RANGES* activates the entry of subranges and the associated transducer factors. The selection bar marks the frequency values last active.

***Start* - Entry of start frequency of subrange**
***Stop* - Entry of stop frequency of subrange**

The individual subranges have to be linked without a gap. That is why the start frequency is already defined from the second subrange (= stop frequency of previous range).

After entering the first frequency value the table can be edited. The two *INSERT LINE* and *DELETE LINE* softkeys are displayed. Some values are changed at a later time by marking the field and by entering the new value. It should be noted that both the stop frequency of a particular subrange and the start frequency of the subsequent subrange are changed to the same extent.

IEC/IEEE-bus command

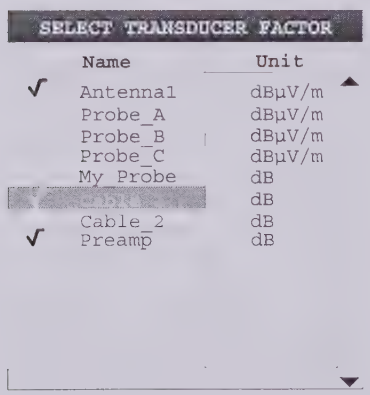
```
:[SENSe<1|2>:]CORRection:TSET:RANGe<1..10>
                          <freq>,<freq>,<name>..
```

***Sel fac*- Selection of factors for the subrange**

A check sign in column *Sel Fac* (select factor) indicates whether one or several transducer factors were selected for the subrange.

The permissible transducer factors for the marked subrange can be selected in a selection box. Only factors matching with the unit of the set and fully covering the selected subrange are permissible.
After each change of range limits, ESI thus checks the factor list and, if required, rebuilds it.
After reducing the start frequency or increasing the stop frequency of a range it may happen that the factors defined for this range no longer fully cover the range. These factors are deleted for this range when the transducer factor table is opened next time.

A maximum of 4 transducer factors can be switched on at the same time in each subrange. If none of them is switched on, 0 dB is assumed as a factor for the whole subrange.



IEC/IEEE-bus command --

INSERT LINE

The *INSERT LINE* softkey inserts a free line above the marked subrange.

DELETE LINE

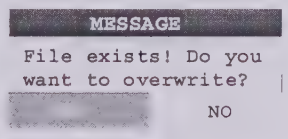
The *DELETE LINE* softkey deletes the marked subrange (whole line). The following subranges move up.

In both cases ESI checks that the ranges follow each other without a gap.

IEC/IEEE-bus command --

SAVE TRD SET

The *SAVE TRD SET* softkey saves the changed table in a file on the internal hard disk. If a transducer name with the same name already exists, a corresponding query is performed beforehand:



After pressing ENTER, the data set is overwritten on the hard disk.
If the saved set is switched on, the new values will be used immediately.

IEC/IEEE-bus command -- (executed automatically)

PAGE UP

The *PAGE UP* and *PAGE DOWN* softkeys set the table to the next or previous page.

PAGE UP

The softkeys are locked during selection of factors in the right table.

Preamplification and Preselection

In the frequency range up to 7 GHz, ESI has a preselection with switchable preamplifier which can be selected by the user in the analyzer mode. The preselection is always active in the receiver mode.

The 20 dB preamplifier is available only if the preselection is switched on.

Preselection

The frequency range 20 Hz to 7 GHz is distributed over nine filter bands. Two fixed-tuned filters are used up to 2.025 MHz, six tracking passband filters from 2.025 to 1000 MHz and a fixed-tuned high-pass filter above 1 GHz.
The filters are switched by a relay at 150 kHz and by PIN-diode switches above 150 kHz.

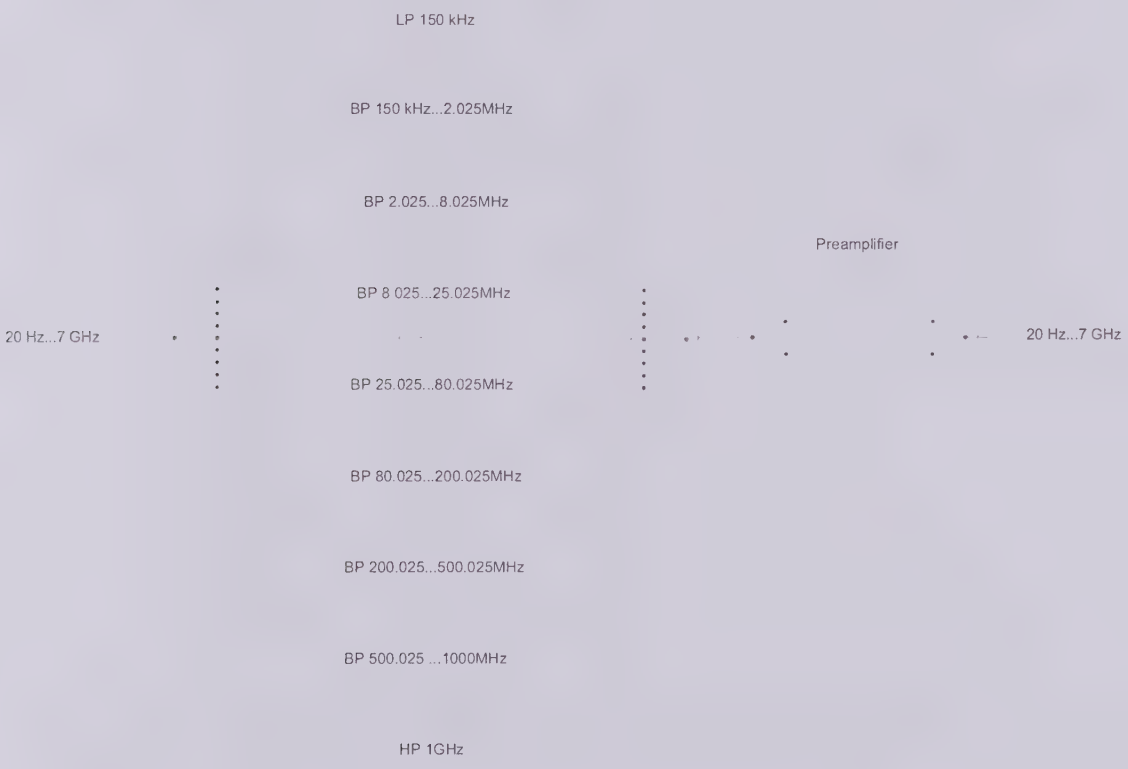


Fig. 4-5 Preselection and preamplifier

CONFIGURATION SETUP menu:

PRESELECT
ON OFF

The *PRESELECT ON/OFF* softkey switches the preselection on or off.

The softkey is available only in the analyzer mode.

IEC/IEEE bus command `:INPut<1|2>:PRESelection[:STATe] ON|OFF`

Preselection causes additional dependencies which are automatically taken into account in the coupled setting.

- With the preselection active, the FFT bandwidths are not available.
- With the preselection active, the start frequency is set to 150 kHz in the FULL SPAN setting to avoid permanent switching of the relay at the band limit of 150 kHz.
- When the measurement is performed with activated preselection, it must be ensured that the resolution bandwidth is not greater than the preselection bandwidth. On entering the resolution bandwidth (RBW), this value is limited depending on the selected start frequency:

Start frequency	Max. RBW
f_{start} < 150 kHz	100 kHz
150 kHz ≤ f_{start} < 8.025 MHz	500 kHz
8.025MHz ≤ f_{start} < 25.025 MHz	2 MHz
25.025 MHz ≤ f_{start} < 80.025 MHz	5 MHz
f_{start} ≥ 80.025 MHz	10 MHz

- Due to the limited tuning speed of the tracking passband filters, the maximum sweep rate (7 GHz / 5 ms) can no longer be attained with the preselection switched on. The minimum settable sweep time is obtained from the sum of the minimum possible sweep times in the associated filter bands.

Filter band	Min. sweep time for filter band
20 Hz to 150 kHz	-
150 kHz to 2,025 MHz	-
2.025 to 8.025 MHz	500 ms
8.025 to 25.025 MHz	50 ms
25.025 to 80.025 MHz	50 ms
80.025 to 200.025 MHz	50 ms
200.025 to 500.025 MHz	50 ms
500.025 to 1000 MHz	-
1000 to 7000 MHz	-

A longer sweep time is distributed over the filter bands such that only the times in the bands with the shorter sweep times are increased. The time available is uniformly distributed over all bands provided all bands are swept at the same speed.

Preamplification

Switching on the preamplifier diminishes the total noise figure of the ESI, thus increasing the sensitivity. The preamplifier follows the preselection filters so that the risk of overdriving by strong out-of-band signals is reduced to a minimum. The signal level of the subsequent mixer is 20 dB higher so that the maximum input level is reduced by the gain of the preamplifier. The total noise figure of ESI is reduced from approx. 18 dB to approx. 11 dB with the preamplifier switched on. The use of the preamplifier is recommended when measurements with a maximum sensitivity are to be performed. If the measurement should be performed at maximum dynamic range, the preamplifier should be switched off.

The gain of the preamplifier is automatically considered in the level display. On switching on the preamplifier the RF attenuation or the reference level is adapted depending on the settings of the ESI.

CONFIGURATION SETUP menu:

PREAMP
ON OFF

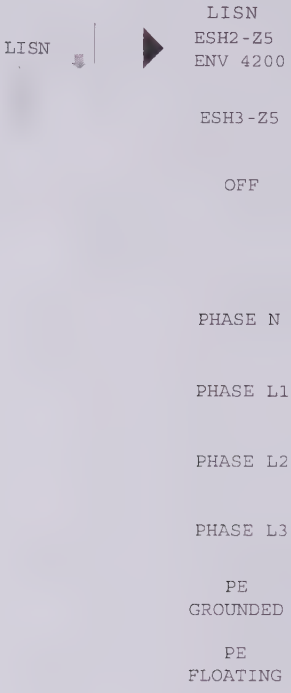
The *PREAMP ON/OFF* softkey switches the preamplifier on or off.

The softkey is available only in the analyzer mode when the measurement with preselection is activated.

IEC/IEEE bus command `:INPut<1|2>:GAIN:STATe ON | OFF`

Control of V-networks (LISNs)

CONFIGURATION SETUP menu:



The *LISN* softkey opens the submenu including the settings required to control V-networks (LISNs).

Softkeys *ESH2-Z5/ENV 4200*, *ESH3-Z5* and *OFF* or *PHASE N*, *PHASE L1*, *PHASE L2* and *PHASE L3* as well as *PE GROUNDED* and *PE FLOATING* are toggle keys. Only one of them can be activated at a time.

ESH2-Z5
ENV 4200

ESH3-Z5

OFF

Softkeys *ESH2-Z5/ENV 4200*, *ESH3-Z5* and *OFF* allow to select the V-network to be controlled via the user port.

ESH2-Z5/ENV 4200	four-line V-network is controlled,
ESH3-Z5	two-line V-network is controlled,
OFF	remote control is deactivated.

IEC/IEEE-bus command

```
INPut:LISN[:TYPE]  TWOPhase | FOURphase | OFF
```

PHASE N

PHASE L1

PHASE L2

PHASE L3

Softkeys *PHASE N, PHASE L1, PHASE L2* and *PHASE L3* select the phase of the V-network on which the RFI voltage is to be measured.

PHASE N	RFI on phase N is measured,
PHASE L1	RFI on phase L1 is measured,
PHASE L2	RFI on phase L2 is measured (only for ESH2-Z5/ENV 4200),
PHASE L3	RFI on phase L3 is measured (only for ESH2-Z5/ENV 4200).

IEC/IEEE-bus command `INPut:LISN:PHASe L1 | L2 | L3 | N`

PE GROUNDED

PE FLOATING

Softkeys *PE GROUNDED* and *PE FLOATING* switch the protective earth conductor chokes on or off.

PE GROUNDED	protective earth conductor choke switched off,
PE FLOATING	protective earth conductor choke switched.

IEC/IEEE-bus command `INPut:LISN:PEARth GROunded | FLOating`

Enabling Firmware Options

CONFIGURATION SETUP menu:

OPTIONS

The *OPTIONS* softkey opens a submenu for entering keywords for new firmware options (Application Firmware Modules). Options which are already available are indicated in a table that is opened when the menu is called.

ENABLE NEW OPTION

The *ENABLE OPTION* softkey activates the entry of a keyword for a firmware option.

One or several keywords may be specified in the entry field. When a valid keyword is entered, the message *OPTION KEY OK* appears in the info line and the option is written into the *FIRMWARE OPTIONS* table.

The *FIRMWARE OPTIONS* table can also be displayed using the *FIRMWARE OPTIONS* softkey in the *INFO* menu.

If a keyword is invalid the message *OPTION KEY INVALID* is displayed in the info line.

IEC/IEEE-bus command `--`

External Reference Oscillator

In general, the ESI can generate all internal oscillators from either the internal or an external reference oscillator. A 10 MHz crystal oscillator is used as the internal reference source. A reference oscillator output is also available at the rear panel via the EXT REF IN/OUT connector.
This output can be used, e.g., to synchronize other instruments to the ESI. This connector can also be used as an input connector for application of an external frequency standard. The ESI requires that the frequency of the external standard be entered so that the internal oscillators can be synchronized to it.

CONFIGURATION SETUP Menu:

REFERENCE INT EXT

The *REFERENCE INT EXT* softkey toggles between the internal and external references.

IEC/IEEE-bus command `:[SENSe<1|2>:]ROSC:SOURce INT | EXT`

EXT REF FREQUENCY

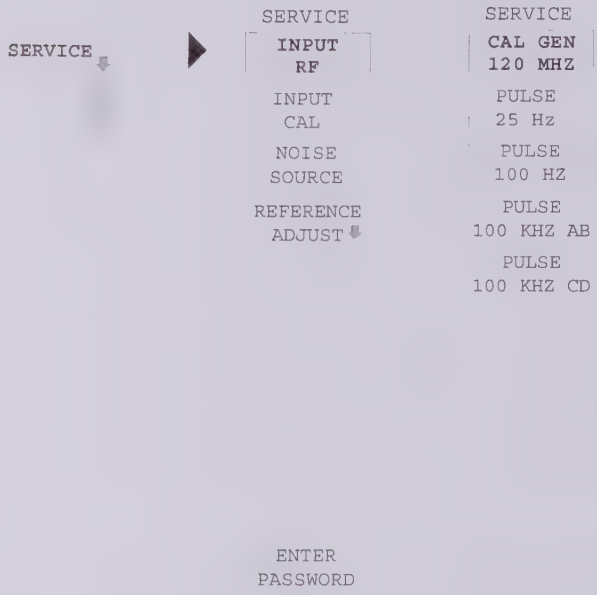
The *EXT REF FREQUENCY* softkey activates the entry of the frequency of the external source.
Range of input values is 1 MHz to 16 MHz in 1 MHz steps.

IEC/IEEE-bus command `:[SENSe<1|2>:]ROSC:EXT:FREQ 13 MHz`

Service Functions

The service menu offers a variety of additional functions which are used for maintenance and/or trouble shooting. The service functions are not necessary for normal measurements, however, incorrect use can impair the functionality and/or data integrity of the ESI. Therefore, many of the functions can only be used after entering a password.

CONFIGURATION SETUP menu:



The *SERVICE* softkey calls the service submenu.

INPUT RF

The *INPUT RF* and *INPUT CAL* softkeys are mutually exclusive selection switches. Only one switch can be activated at any one time. They switch the input to the ESI between the *INPUT RF* connector (default) and the internal calibration source (120 MHz, -40 dBm).

After *PRESET*, *RECALL* or ESI power on, the *INPUT RF* is always selected.

INPUT CAL

IEC/IEEE-bus command

```
:DIAGnostic:SERVice:INPut[:SELect] RF| CAL
```

NOISE SOURCE

The *NOISE SOURCE* softkey switches the supply voltage for an external noise source on or off. The source is connected to the NOISE SOURCE connector on the instrument's rear panel.

The dc voltages on the connector are described in Chapter 8.

IEC/IEEE-bus command `:DIAGnostic:SERVice:NSOurce ON | OFF`

CONFIGURATION SETUP SERVICE menu:

The *REFERENCE ADJUST* softkey opens a submenu used to adjust the frequency precision of the reference oscillator.
The value should be modified only after the frequency precision was checked and found to be erroneous (setting range 0 to 4095).

For more information about how to perform the adjustment of the frequency precision refer to service manual instrument (delivered with the ESI).
The modified reference value is preserved when the menu is closed.

The current adjustment value can be permanently stored in an EEPROM in the instrument.

Caution: *As the specifications of the whole instrument depend directly on the setting of the reference oscillator (frequency precision), storing incorrect adjustment values should be avoided.*

Note: *If no adjustment value has been stored (REFERENCE PROG softkey) before the analyzer is switched off and on again, the factory-set value of the reference frequency or the value that has been programmed last will be used.*

REFERENCE

The *REFERENCE* softkey adjusts the frequency precision of the reference oscillator.

IEC/IEEE-bus command
`:[SENSe<1|2>:]ROSC:[INT:]TUNe <num_value>`

REFERENCE PROG

The *REFERENCE PROG* softkey stores the current adjustment value in an EEPROM in the instrument.

IEC/IEEE-bus command
`:[SENSe<1|2>:]ROSC:[INT:]TUNe:SAVe`

ENTER PASSWORD

The *ENTER PASSWORD* softkey allows the entry of a password.

The ESI has a variety of service functions which, if incorrectly used, can impair the functionality of the instrument. These functions can only be accessed with a password (*ENTER PASSWORD)*.

IEC/IEEE-bus command `:SYSTem:PASSword[:CENable] <string>`

CAL GEN
120 MHZ

The *CAL GEN 120 MHZ* softkey switches on the 120 MHz calibration source (default setting).

IEC/IEEE-bus command -

PULSE
25 HZ

The *PULSE 25 HZ* softkey switches on the 25 Hz pulse generator.

IEC/IEEE-bus command -

PULSE
100 HZ

The *PULSE 100 HZ* softkey switches on the 100 Hz pulse generator.

IEC/IEEE-bus command -

PULSE
100 KHZ AB

The *PULSE 100 KHZ AB* switches on the low frequency 100 kHz pulse generator.

IEC/IEEE-bus command -

PULSE
100 KHZ CD

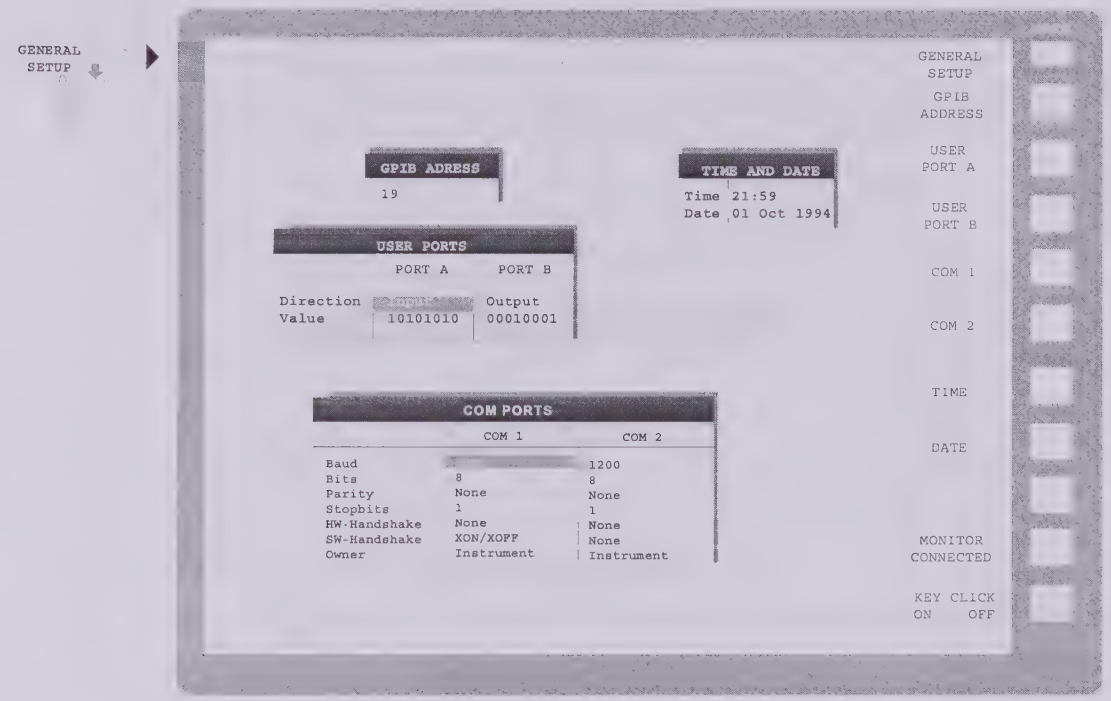
The *PULSE 100 KHZ CD* switches on the high frequency 100 kHz pulse generator.

IEC/IEEE-bus command -

Setting the Interface Configuration and Time

The *GENERAL SETUP* softkey opens a submenu in which the general instrument setup can be entered. The current settings are displayed as tables on the screen where they may be edited.

CONFIGURATION SETUP menu:



IEC/IEEE-Bus Address Selection

CONFIGURATION SETUP-GENERAL SETUP submenu:

GPIB ADDRESS

The *GPIB ADDRESS* softkey activates the entry of the IEC/IEEE-bus address.

The range is 0 to 31. The default setting is 20.

IEC/IEEE-bus command

```
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 20
```

User Port Configuration

The instrument provides two parallel interfaces, each of which is 8 bits wide. Over these ports, arbitrary bit patterns can be output or input. The interfaces are designated *USER PORT A* and *USER PORT B*.

CONFIGURATION SETUP-GENERAL SETUP submenu:

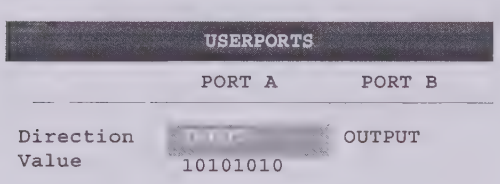
USER PORT A

The USER PORT A and *USER PORT B* softkeys activate the columns PORT A and PORT B, respectively, in the USERPORTS table for entry of the parameters for both of the parallel interfaces in the instrument. Because the two interfaces are configured in the same manner, how to configure an interface is described in the following using *USER PORT A*.

The following parameters need to be configured in the table:

Direction Direction of data transmission

Value Indication/entry of current value

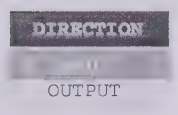


Direction – Direction of data transmission

The *DIRECTION* parameter determines in which direction the interface transmits data.

INPUT read operation

OUTPUT write operation

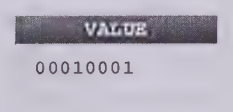


IEC/IEEE-bus command `:INPut<1|2>:UPORt<1|2>:STATe ON|OFF`
`:OUTPut<1|2>:UPORt<1|2>:STATe ON|OFF`

Value – Indication/Entry of current value

The *VALUE* parameter shows the current value of the data at the port for data input as well as for data output. The displayed data is in binary format with the least significant bit (LSB) on the right.

If the port is configured as an *OUTPUT* then, the displayed value can be edited. Data entry must also be in binary format (i.e., only the digits 0 and 1 are accepted).



IEC/IEEE-bus command
`:INPut<1|2>:UPORt<1|2>[:VALue]?`
`:OUTPut<1|2>:UPORt<1|2>[:VALue] <Binary>`

Serial Interface Configuration

CONFIGURATION SETUP-GENERAL SETUP submenu:

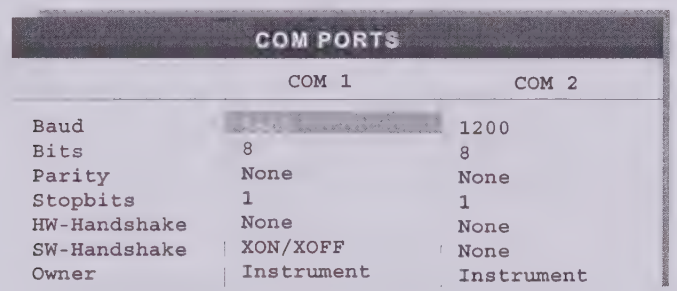
COM PORT 1

The *COM PORT 1* and *COM PORT 2* softkeys activate the columns COM1 and COM2, respectively, for entry of the serial interface parameters Since the two interfaces are configured in the same manner, how to configure an interface is described in the following using *COM PORT 1*.

COM PORT 2

The following parameters must be in the table:

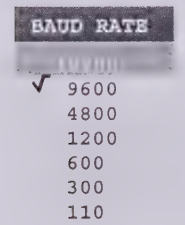
Baud rate	data transmission rate
Bits	number of data bits
Parity	bit parity check
Stop bits	number of stop bits
HW-Handshake	hardware handshake protocol
SW-Handshake	software handshake protocol
Owner	assignment of the serial port to the ESI or computer



Note: *A serial interface (COM1 or COM2) cannot be used for another purpose if a mouse is connected to it.*

Baud – Data transmission rate

Allowed are the indicated values between 110 and 19200 baud. The default setting is 9600 baud.



IEC/IEEE-bus command

```
:SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD 9600
```

Bits – Number of data bits per word

For the text transmission without special characters, 7 bits are adequate. For binary data as well as text with special characters, 8 bits must be selected (default setting).

IEC/IEEE-bus command

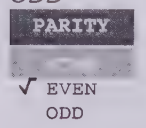
```
:SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITS 7 | 8
```

***Parity* – Bit parity check**

NONE no parity check (default setting)

EVEN even parity check

ODD odd parity check

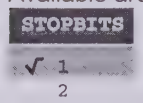


IEC/IEEE-bus command

```
:SYSTem:COMM:SERial<1|2>[:RECeive]:PARity[:TYPE]
                                        EVEN| ODD| NONE
```

***Stop bits* – Number of stop bits**

Available are 1 and 2. The default setting is 1 stop bit.



IEC/IEEE-bus command

```
:SYSTem:COMMunicate:SERial<1|2>[:RECeive]:SBITs 1|2
```

***HW-Handshake* – Hardware handshake protocol**

The integrity of data transmission can be improved through the use of a hardware handshake protocol which prevents uncontrolled transmission of data and the resulting possible loss of data bytes. With the hardware handshaking procedure, additional interface lines are used to transmit acknowledge signals with which the data transmission can be controlled and, if necessary, stopped until the receiver is ready to receive data again.

A prerequisite for handshaking is, however, that the interface lines (DTR and RTS) are provided between the sender and receiver. For a simple, 3-wire connection, this is not the case and a hardware handshake cannot be realized.

Default setting is *NONE*.

IEC/IEEE-bus command

```
:SYSTem:COMM:SERial<1|2>:CONTrol:DTR IBFull|OFF
:SYSTem:COMM:SERial<1|2>:CONTrol:RTS IBFull|OFF
```

***SW-Handshake* – Software handshake protocol**

Besides the hardware handshake procedure using interface lines, it is also possible to achieve the same effect by using a software handshake protocol. In this case, control bytes are transmitted in addition to the normal data bytes. These control bytes can be used, as necessary, to stop data transmission until the receiver is ready to receive data again.

In contrast to hardware handshaking, software handshaking can be realized even for a simple, 3-wire connection.

Software handshaking, however, does have one limitation. Software handshaking cannot be used for the transmission of binary data since, the control characters XON and XOFF require bit combinations that are also used for binary data transmission.

Default setting is *NONE*.

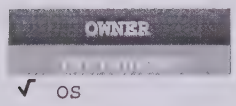
IEC/IEEE-bus command

```
:SYSTem:COMM:SERial<1|2>[:RECeive]:PACE XON|NONE
```

***Owner* – Assignment of the interface**

The serial interface can be assigned either to the instrument or the computer (operating system, OS).

INSTRUMENT	Assignment to the instrument means that outputs to the port by the OS are not possible as any output would be lost.
OS	Assignment to the operating system means that the instrument cannot use the port, i.e. it is not possible to remote control the instrument via this port.



IEC/IEEE-bus command --

Setting the Date and Time

CONFIGURATION SETUP-GENERAL SETUP submenu:

TIME

The *TIME* softkey activates the entry of time for the internal real time clock. In the corresponding dialog box, the time is partitioned into two input fields so that hours and minutes can be entered independently.

IEC/IEEE-bus command `:SYSTem:TIME 0...23, 0...59, 0...59`

DATE

The *DATE* softkey activates the entry of the date of the internal real-time clock. In the corresponding dialog box, the date is partitioned into 3 input fields so that day, month and year can be input separately.

For the selection of the month, pressing a units key opens a list of abbreviations for the months.

IEC/IEEE-bus command `:SYSTem:DATE <num>,<num>,<num>`

Connecting the External Monitor

Submenu *CONFIGURATION SETUP-GENERAL SETUP*:

MONITOR CONNECTED

The *MONITOR CONNECTED* softkey informs the unit that an external monitor is available at PC MONITOR connector
The external monitor displays the Windows NT mask.

IEC/IEEE-bus command - -

Switching the Beeper ON/OFF

CONFIGURATION SETUP-GENERAL SETUP submenu:

KEY CLICK ON - OFF

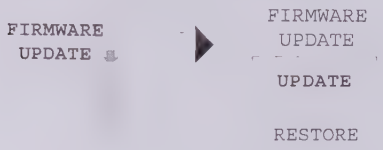
The *KEY CLICK ON/OFF* softkey switches the beeper on or off. The beeper acknowledges each key stroke with a beep.

IEC/IEEE-bus command - -

Firmware Update

New firmware versions can be installed from the integral disk drive. The firmware update kit contains several disks.
The installation program is called in the *SETUP* menu.

CONFIGURATION SETUP sidemenu:



The *FIRMWARE UPDATE* softkey opens the submenu for the installion of a new firmware version.

`UPDATE`

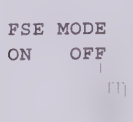
The *UPDATE* softkey starts the installation program and guides the user through the remaining steps of the update procedure.

`RESTORE`

The *RESTORE* softkey restores the previous firmware version

Compatibility to FSE Instrument Family

CONFIGURATION SETUP sidemenu:



The *FSE MODE ON/OFF* softkey determines whether theESI is FSE-compatible after a preset. Following a preset, the ESI has not the same settings as an FSE. With compatibility, the ESI has the same default settings as FSE after a preset.

IEC/IEEE-bus command `:SYSTem:PRESet:COMPatible OFF | FSE`

Status Display-Remote/Manual Control – *STATUS Key Group*

STATUS

SRQ

REMOTE

LOCAL

The *SRQ* LED, the *REMOTE* LED and the *LOCAL*. key are contained in the *STATUS* key group.

- The *SRQ* LED indicates that a service request from the instrument has been asserted on the IEC Bus.

- The *REMOTE* LED indicates that the instrument is under remote control.

- The *LOCAL* key switches the instrument from remote to manual control, with the assumption that the remote controller has not previously set the LOCAL LOCKOUT function.

A change in the control mode comprises:

- **Enabling the Front Panel Keys**
  Under remote control, the softkey menu is turned off and all keys, with the exception of *PRESET* and *LOCAL*, are disabled. Returning to manual mode enables all disabled keys. The main menu of the current mode is selected as the softkey menu..

- **Turning off the *REMOTE* LED**

- **Generating the message OPERATION COMPLETE**
  If the synchronization via *OPC, *OPC? or *WAI is active when the *LOCAL* softkey is pressed, any measurement procedure that is running is aborted and synchronization is achieved by setting the corresponding bits in the registers of the status reporting system.

- **Setting Bit 6 (User Request) of the Event Status Register**
  If the status reporting system is configured appropriately, setting this bit immediately elicits a service request (*SRQ*) which is used to inform the controller that the user wishes to return to front-panel control. This information can be used, e.g., to interrupt the control program so that the user can make the necessary manual corrections to instrument settings. This bit is set each time the *LOCAL* key is pressed.

- The *LOCAL* key aborts a running macro. The continuation of the macro is not possible.

IEC/IEEE-bus command `CALL IBLOC(analyzer%)`

Measurement Documentation – *HARDCOPY* Key Group

Note: *The installation of additional printer drives is described in chapter 1, section "Installation and Configuration of Printers".*

Printing Data – *START* Key

The instrument uses the printer function of Windows NT to output hardcopies. Any printer supported by Windows NT can be used. In addition, the instrument permits data output in the usual data formats WMF, EWMF and BMP which enable hardcopies to be directly inserted into other documents. Network printers can be used if the instrument is connected to a network.

HARDCOPY

START

SE NG

The *START* key initiates the printing of measurement/ instrument status data. The instrument can distinguish between two different printers, each of which may be individually configured, e.g., a laser printer and a ink jet printer. All documents are printed on the printer which is currently active.

IEC/IEEE-bus command `:HCOPy[:IMMediate<1|2>]`

Pressing the *HARDCOPY START* key starts the print job. The settings under Windows NT and in the *HARDCOPY SETTINGS* menu determine the printer configuration. All of the display items to be printed out are written to the printer buffer of Windows NT. Since the printer runs in the background, the instrument may be operated immediately after pressing the *START* key.

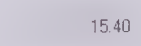
When *COPY SCREEN* is selected in menu *HARDCOPY SETTINGS*, all the measurememt diagrams with traces and status displays are printed as they appear on the screen. Softkeys, open tables and data entry fields are not printed out. Specific traces can be printed out with the *COPY TRACE* function. With *COPY TABLE*, tables can be printed out.

If *CLIPBOARD* is active in the *HARDCOPY DEVICE* submenu the clipboard can be used to directly transfer hardcopies to Windows applications. The copy is written in the clipboard by pressing *HARDCOPY START*. The user can then change to another Word document and insert the clipboard content into the document with EDIT - PASTE by using the key combination CTRL+V.

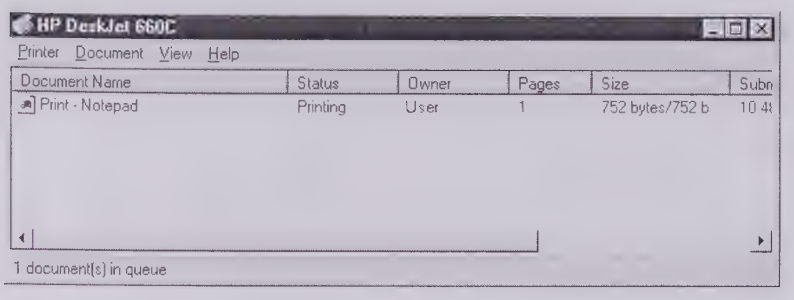
If the *PRINT TO FILE* option in the *HARDCOPY DEVICE* submenu is selected, the printout is directed to a file. When the *HARDCOPY START* is pressed , the file name to which the output data are to be written is requested.

If the *START* key is pressed while printing is in progress, a second output can be released which can also be joined to the printer queue. Any number of print jobs can be released consecutively.

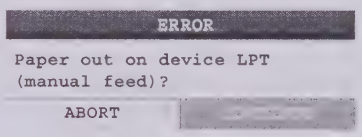
Current print jobs can be aborted only by cancelling the entries in the Windows NT printer queue. After starting the print a printer symbol is displayed in the task bar near the time indication.



A double-click on this symbol opens a window containing the entries of the printer queue. The relevant print order can be cancelled by marking it with the mouse and pressing the DEL key.



While a print job is in progress, problems may occur in the printer. If, while printing, the printer issues a PAPER OUT message, i.e., no more paper is available, the user will be prompted by the following message



to load paper into the printer. The print job will then be either continued (CONTINUE) or aborted (ABORT).

Switchover between b/w and colored printouts is possible with the *COLOR ON/OFF* softkey provided that an appropriate printer is connected. The colors of the printout correspond exactly to those on the screen, ie a red trace will be output in red.
To change the colors of the objects on the printout, the screen colors have to be changed in *DISPLAY-CONFIG DISPLAY* menu. One exception is the color of the background and the color of the diagrams. The output background is always white irrespective of the screen color and the diagrams are always black.
If several traces are to be output one after the other on the same sheet different colors can be chosen for each trace with the *TRC COLOR AUTO INC* softkey (Trace Color Auto Increment).

On most b/w printers, a better printout of the color screen is obtained on hardcopies if the color information is converted into gray shades. For this, the color output in menu *HARDCOPY SETTINGS* is to be activated (COLOR ON).

Printing Configuration – *SETTINGS* Key

HARDCOPY SETTINGS menu:

The *SETTINGS* key opens the menu to configure the printout.

The recommended procedure for configuring the printout is as follows:

- Configure the desired printer and select the interface over which the output is to take place by using Windows NT and the *HARDCOPY DEVICE* softkey.
- Select the display items to be printed with the *COPY SCREEN*, *COPY TRACE softkeys*.
- Select between coloured and b/w printouts with the *COLOR ON/ OFF* and *TRC COLOR AUTO INC* softkeys.
- Enter comment applicable to the diagram or add a title for the overall printout by using the *ENTER TEXT* softkey.
- Select the page format (*QUADRANT, FULL PAGE*) through use of the *SELECT QUADRANT* softkey.

The *COPY SCREEN, COPY TRACE* and *COPY TABLE* softkeys are selection switches, i.e., only one function can be enabled at any one time. The push buttons are used for selection only and do not initiate a print job. The actual printing is initiated by the *HARDCOPY START* key.

Selection of Displayed Elements and Colour Settings

HARDCOPY SETTINGS menu:

COPY SCREEN

The *COPY SCREEN* softkey selects the output of test results.

All the diagrams, traces, markers, marker lists, display lines, limit lines etc. are printed out as long as they are displayed on the screen. Softkeys, tables and open data entry fields are not printed out. However, comments, title, date, and time entered are printed out at the bottom of the printout. The logo appears at the top left of the printout.

IEC/IEEE-bus command `:HCOPy:ITEM:ALL`

COPY TRACE

The *COPY TRACE* softkey selects the output of all traces displayed on the screen without any auxiliary information. Specifically, no markers or display lines are printed.

IEC/IEEE-bus command
`:HCOPy:ITEM:WINDow<1|2>:TRACe:STATe ON|OFF`

COPY TABLE

The *COPY TABLE* softkey selects the output of all tables visible displayed on the screen.

IEC/IEEE-bus command
`:HCOPy:ITEM:WINDow<1|2>:TABle:STATe ON|OFF`

COLOR ON OFF

The *COLOR ON/ OFF* softkey selects a coloured or b/w printout.

After having changed the printer driver or the hardcopy device (in submenu, *HARDCOPY SETTINGS*) the softkey is automatically switched to *ON*.
One exception is printer driver HP PCL4 which only supports b/w printouts. In this case, the softkey cannot be operated.

IEC/IEEE-bus command `:HCOPy:DEVice:COLor ON | OFF`

TRC COLOR AUTO INC

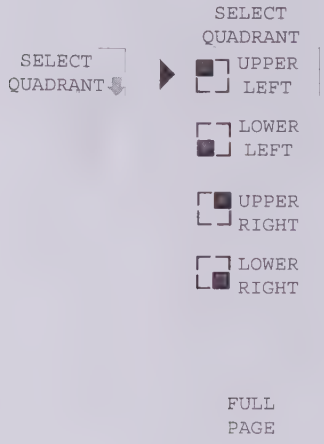
The *TRC COLOR AUTO INC* softkey automatically switches the colours of the traces on to the next printout. On the second printout, trace 1 has the colour of trace 2, trace 2 the colour of trace 3 etc. The fourth printout starts with the first colour. With the softkey switched off, the colours of the traces are reset to their original state.

When changing the printer driver or the hardcopy device (both in submenu *HARDCOPY SETTINGS*) as well as the selection b/w printout (softkey *COLOR ON/ OFF* in position *OFF*), softkey *TRC COLOR AUTO INC* is switched off.

IEC/IEEE-bus command
`:HCOPy:ITEM:WINDow<1|2>:TRACe:CAINcrement ON | OFF`

Selection of Hardcopy Format

HARDCOPY SETTINGS-SELECT QUADRANT submenu:



The *SELECT QUADRANT* softkey calls the the submenu for selection of *QUADRANT*the location of the display screen graphics on the printed page.

FULL PAGE

The *FULL PAGE* softkey switches quadrant printing off, i.e., printing now takes place at full size. The information as to which quadrant was last selected is also lost. *FULL PAGE* is the default setting.

IEC/IEEE-bus command `:HCOPy:PAGE:DIMensions:FULL`

UPPER LEFT

LOWER LEFT

UPPER RIGHT

LOWER RIGHT

The *UPPER LEFT, LOWER LEFT* as well as *UPPER RIGHT, LOWER RIGHT* softkeys select the page quadrants where the printed data will be positioned. In this case, the actual size of the data printed on the page is reduced to 25% of normal size. This reduction is independent of how the graphics are distributed on the display screen. Thus, for two measurement windows (*SPLIT SCREEN*), both measurement diagrams shown on the display are placed in the chosen quadrant. Thus, up to a maximum of 8 measurement windows can be printed on one page. (4 print commands for a *SPLIT SCREEN* display, each to a different quadrant)

IEC/IEEE-bus command

`:HCOPy:PAGE:DIMensions:QUADrant 1|2|3|4`

Entry of Comment Text

HARDCOPY SETTINGS-ENTER TEXT submenu:

ENTER TEXT ▶ ENTER TEXT COMMENT SCREEN A / COMMENT SCREEN B

The *ENTER TEXT* softkey calls the submenu for editing the commentary for the individual windows. The comment text appears in the print-out, but does not appear on the display screen.

If a comment is not to appear on the printout, it has to be deleted. By pressing *PRESET,* all comments will be deleted.

TITLE

COMMENT SCREEN A

COMMENT SCREEN B

The *COMMENT SCREEN A* softkey opens an entry field in which a comment of at most two lines (60 characters per line) can be entered for screen A or screen B. If the user enters more than 60 characters, the overflow characters appear on the second line on the print-out. At any point, a manual line-feed can be forced by entering the @ character. The comment is printed below the corresponding screen.

IEC/IEEE-bus command

```
:HCOPy:ITEM:WINDow<1|2>:TEXT    <string>
```

TITLE

The *TITLE* softkey activates a single line entry box for entering a title for the complete print-out with a maximum of 60 characters.

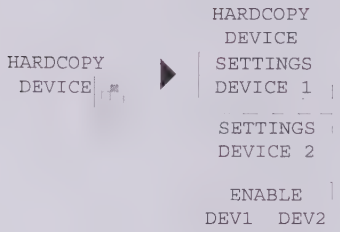
IEC/IEEE-bus command

```
:HCOPy:ITEM:LABel:TEXT    <string>
```

Selection and Configuration of the Printer

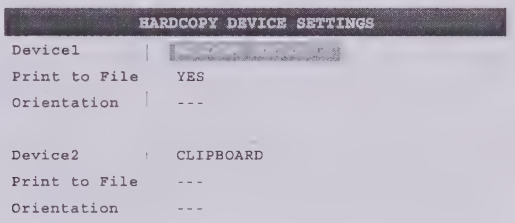
The instrument permits two different printers to be configured. One of the devices is defined as the active device and can be used for hardcopies.
The printers are mainly installed and configured under Windows NT and and the settings are valid for all Windows applications (see Chapter 1, section "Connecting an Printer"). The active device and the settings which concern only the output of hardcopies are selected in menu *HARDCOPY DEVICE.*.

HARDCOPY SETTINGS submenu:



The *HARDCOPY DEVICE* softkey switches to the submenu which is used for the selection/configuration of the two printers.

When the sub-menu is called, the corresponding table is displayed. The *SETTINGS DEVICE 1* softkey is active and the selection bar is located at the *DEVICE1* line in the corresponding column of the table.



SETTINGS DEVICE 1

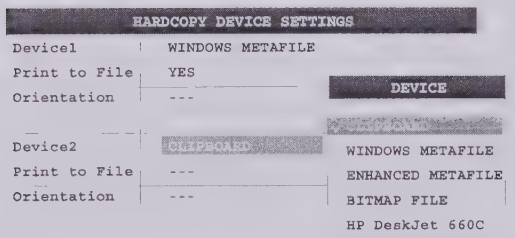
The *SETTINGS DEVICE 1* softkey permits the selection and configuration of the printer DEVICE 1. The *SETTINGS DEVICE 2* softkey is used to configure DEVICE 2.

SETTINGS DEVICE 2

The actual selection of the active printer takes place with the *ENABLE DEV1 DEV2* softkey in the *HARDCOPY DEVICE* sub-menu.

Device

The selection of the printer/language for DEVICE 1 and DEVICE 2 is made in this line.



Three file formats and the Windows NT clipboard are always available, even if a printer has not yet been installed under Windows NT. All installed printers are listed below in alphabetic order.
The printer installation is described in Chapter 1, Section "Installation and Configuration of Printers".

CLIPBOARD The hardcopies are copied to the Windows NT clipboard. This permits to obtain a printout of high quality which can be directly inserted into other Windows applications (menu EDIT | PASTE or key combination CTRL+V). The lines 'Print to File', 'Orientation' and 'GPIB Address' are deactivated.

WINDOWS METAFILE and ENHANCED METAFILE

WMF and EWMF are vector graphics formats which can be imported by most graphics and editing programs. EMF is recommended for recent Windows32 applications.

BITMAP FILE BMP is a bitmap format which can also be imported by most programs.

When WMF, EWMF and BMP are selected, the line "Print to File" is automatically set to ON and line "Orientation" deactivated.

IEC/IEEE-bus commands

```
:HCOPy:DEVice:LANGuage WMF|EWMF |BMP |GDI
:HCOPy:DESTination<1|2>
  "MMEM"|"SYST:COMM:PRIN"|"SYST:COMM:CLIP"
:HCOPy:ITEM:FFEed<1|2>:STATe   ON | OFF
```

Print to File

With "Print to File" ON, the printout is directed to a file. In this case the user is prompted to enter a file name on starting the printout.

Note: *This setting is coupled to the corresponding setting under Windows NT.*

IEC/IEEE-bus commands

```
:HCOPy:DESTination<1|2> "MMEM"
:MMEMory:NAME <file_name>
```

Orientation

In this line, the print format of the output page is set to either vertical (= PORTRAIT) or horizontal (= LANDSCAPE).

ENABLE DEV1 DEV2

The *ENABLE DEV1 / DEV2* softkey determines the active printer. The default printer is DEVICE 1, i.e., all output takes place on DEVICE 1.

IEC/IEEE-bus command -- (The numeric suffix after `HCOPy:IMMediate` denotes the first or second device.)

Saving and Recalling Data Sets – *MEMORY* Key Group

The keys in the *MEMORY* group call the following functions:

- Functions for managing storage media (*CONFIG*). This includes among others functions listing files, formatting storage media, copying, and deleting/renaming files.
- Save/recall functions for saving (*SAVE*) settings such as instrument configurations (measurement/display settings, etc.) and saving measurement results from working memory to permanent storage media, or for recalling (*RECALL*) stored data.

The ESI can internally store complete instrument settings with instrument configurations and measurement data in the form of data-sets. The data are stored on the internal hard disk or, if if required, on an external disk. The hard-disk drive and the floppy-disk drive are assigned logical names as usual in PC applications:

Disk drive	A:
hard disk	C:

In addition to saving and recalling complete instrument settings, it is also possible to save/recall subsets of settings. Configuration data and measurement values are stored in separate files. These files have the same name as the data set but have a different extension. A data set therefore comprises several files which have the same name but different extensions (see Table 4-2).

When saving or recallong a data set, the subsets which are to be saved or recallong can be selected in the corresponding menus. This makes it easy to recall specific instrument settings.

When saving and recalling data via the *SAVE* and *RECALL* menus, data subsets are selected in a table in the sub-menu *SEL ITEMS TO SAVE/RECALL*. The relationship between the designations in the table and the contents of the data subsets is shown in Table 4-2

The saved data set files can be copied from one storage medium (e.g. drive C:) to another (e.g. drive A:) or to another directory using the functions found in the *MEMORY CONFIG* menu. However, do not change the file names and extensions when copying. Table 4-2 hows how extensions are assigned to data subsets..

Table 4-2 Assignment of extensions to data subsets

	Extension	Contents	Designation in the table SEL ITEMS TO SAVE/RECALL
Configuration data:	.SET	current settings of the measurement hardware and designation, if present	HARDWARE SETTINGS
	.LIN	data-point tables for the active limit lines	LINES
	.LIA	all defined limit lines	ALL LINES
	.CFG	current configuration of general instrument parameters	GENERAL SETUP
	.HCS	configuration for hardcopy output	HARDCOPY
	.TCI	tracking generator settings (only with option FSE-B10/11)	SOURCE CAL
	.TS1 .TS2	settings for source calibration (only with option FSE-B10/11)	SOURCE CAL
	.TC1 .TC2	correction data for source calibration (only with option FSE-B10/11)	SOURCE CAL
	.CL	used conversion loss (cvl) tables (only with option FSE-B21, External Mixer Output)	USED CVL TABLES
	.CLA	all conversion loss (cvl) tables (only with option FSE-B21, External Mixer Output)	ALL CVL TABLES
	.TS	activated transducer set	TRANSDUCER
	.TSA	all transducer sets	ALL TRANSDUCER
	.TF	transducer factor	TRANSDUCER
	.TFA	all transducer factors	ALL TRANSDUCER
	.COL	user-defined color settings	COLOR SETUP
Measurement results:	.TR1....4	measurement data trace 1 to trace 4	TRACE1...4

Configuration of Memory – *CONFIG* Key

MEMORY CONFIG menu:

MEMORY

The *CONFIG* key opens a menu for managing storage media and files.

SAVE

The *Drive Management* table displays the name and label of the storage medium as well as the free memory.

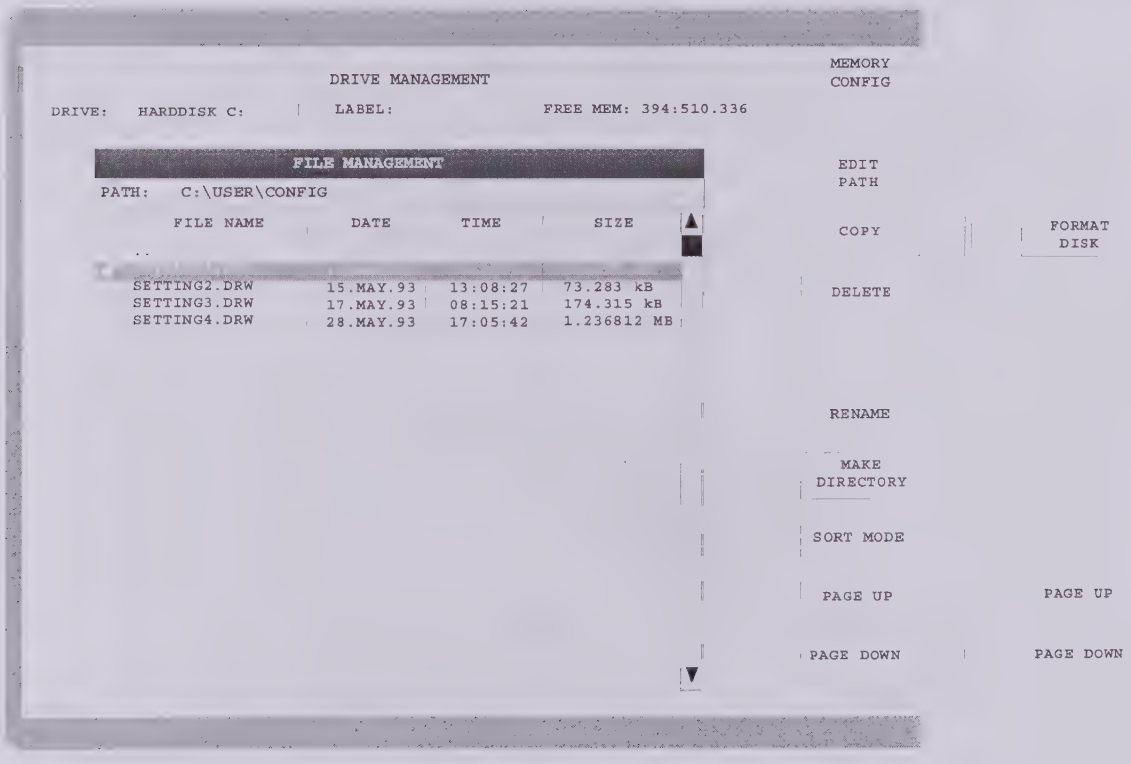
RECALL

The *File Management* table displays the files in the current directory and indicates if any subdirectories are present.

CONFIG

If a directory name is selected, the ESI automatically changes to this directory. Selection of the entry '..' moves the ESI to the next highest directory level.

Note: *It is not possible to change menus as long as a file operation is running.*



EDIT PATH

The *EDIT PATH* softkey activates the entry of the directory which will be used for subsequent file operations.

The new path is included in the *FILE MANAGEMENT* table.

IEC/IEEE-bus commands
```
:MMEMory:MSIS 'C:\'
:MMEMory:CDIRectory 'C:\user\data'
```

COPY

The *COPY* softkey activates the entry of the destination for the copy operation.

By prefixing a disk drive letter (e.g. C:), a file can also be copied to another storage medium. When the *ENTER* key is pressed, the selected files/directories are copied.

IEC/IEEE-bus command
`:MMEMory:COPY 'C:\user\data\setup.cfg','A:'`

DELETE

The *DELETE* softkey deletes the selected files.
To prevent accidental deletion of data, confirmation by the user is requested.

IEC/IEEE-bus command
`:MMEMory:DELete 'TEST01.HCP'`
`:MMEMory:RDIRectory 'C:\test'`

RENAME

The *RENAME* softkey activates the entry of a new name for the selected file or directory.

IEC/IEEE-bus command
`:MMEMory:MOVE 'TEST.CFG', 'SETUP.CFG'`

MAKE DIRECTORY

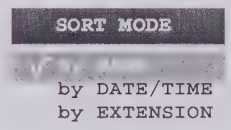
The *MAKE DIRECTORY* softkey creates directories/sub-directories. The use of sub-directories is recommended as a way of structuring the storage medium to make it easier to navigate.

When entering a subdirectory, entry of an absolute path name (e.g.; "\USER\MEAS") as well as the path relative to the current directory (e.g., "..\MEAS") is possible.

IEC/IEEE-bus command `:MMEMory:MDIRectory 'C:\user\data'`

SORT MODE

The *SORT MODE* softkey activates the selection of the sort criteria for the files listed in the *FILE MANAGEMENT* table.



Directory names are at the top of the list after the entry for the next highest directory level ("..").

IEC/IEEE-bus command `--`

FORMAT DISK

The *FORMAT DISK* softkey formats disks located in drive A:.
To prevent accidental destruction of disks data, confirmation by the user is requested.

IEC/IEEE-bus command `:MMEMory:INITialize <msus>`

Saving Data Sets – *SAVE* Key

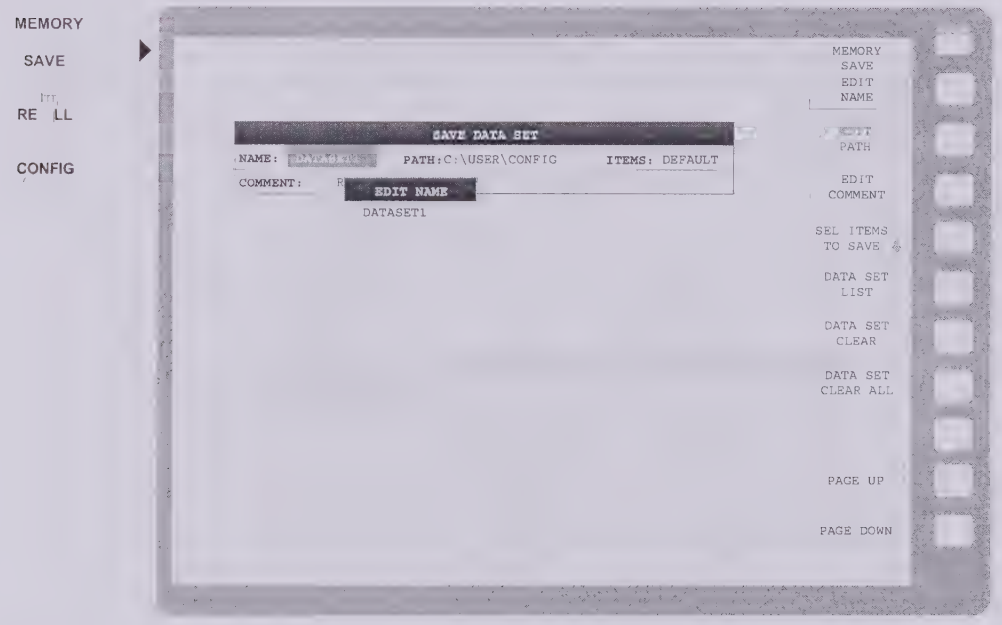
The *SAVE* key activates a menu which contains all functions necessary for saving instrument data.

- Entry of the name of the data set which should be saved. Confirmation of the entry initiates a save operation to store the data set.

  Data set names may contain both alphabetical and numeric characters, in the simplest case only numbers. The simplest example for the input of a data set name is illustrated by the following key strokes:

  <SAVE> <1> <units key>
- Entry of the directory in which the data set should be saved
- Input of data set description
- Selection of the data subsets to be saved (sub-menu SEL ITEMS TO SAVE)
- Indication of all available data sets
- Deletion of all available data sets

MEMORY SAVE menu



The *SAVE DATA SET* table shows the current settings regarding the data set:

Name	Name of data set
Path	Directory in which the data set will be saved
Items	Indicates whether the default selection of data subsets (DEFAULT) or a user-defined selection (SELECTED) will be saved
Comment	Comments about the data set

The *EDIT NAME* softkey for entering the name of the data set to be saved is activated automatically.

Selecting the Data Set for Saving

MEMORY SAVE menu:

EDIT NAME

The *EDIT NAME* softkey activates the entry of the name of the data set to be saved.

Data entry is concluded by pressing one of the units keys which initiates a save operation to store the data set.

IEC/IEEE-bus command `:MMEMory:STORe:STATe 1,'test'`

EDIT PATH

The *EDIT PATH* softkey activates the input of a directory name where the data sets are to be stored.

IEC/IEEE-bus command `--`

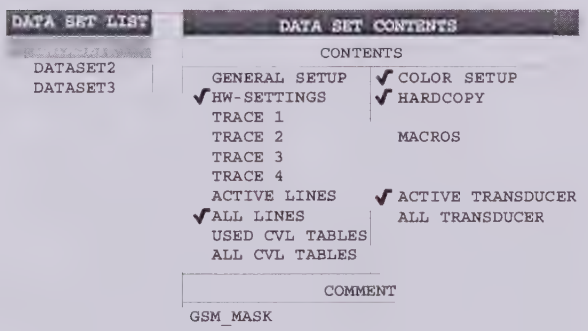
EDIT COMMENT

The *EDIT COMMENT* softkey activates the entry of comments for the current data set. A total of 60 characters are available for this purpose.

IEC/IEEE-bus command `:MMEMory:COMMent <string>`

DATA SET LIST

The *DATA SET LIST* softkey opens the *DATA SET LIST/CONTENTS* table. The *DATA SET CLEAR* and *DATA SET CLEAR ALL* softkeys are also displayed.



The *DATA SET LIST* column lists all the data sets which are stored in the selected directory.

The *CONTENTS* and *COMMENT* lines in the *DATA SET CONTENTS* column indicate the saved data subsets and the comments for the currently selected data set.

IEC/IEEE-bus command `--`

Note: *The current instrument configuration can be easily stored under the name of an existing data set:*

- *Press a units key after selecting a data set*

  The name and the selection of the data subsets for the currently selected data set will be placed in the SAVE DATA SET table. The DATA SET LIST table is closed and, instead, the entry field for the EDIT NAME function with the name of the selected data set is opened.

- *Press a units key.*
  The current instrument configuration is saved as a data set under this name.

DATA SET CLEAR

The *DATA SET CLEAR* softkey clears the marked data set.

IEC/IEEE-bus command `:MMEMory:CLEar:STATe 1,'test'`

DATA SET CLEAR ALL

The *DATA SET CLEAR ALL* softkey deletes all data sets in the current directory.

To prevent all the data sets from being accidentally lost, confirmation from the user is required before actual clearing takes place.

IEC/IEEE-bus command `:MMEMory:CLEar:ALL`

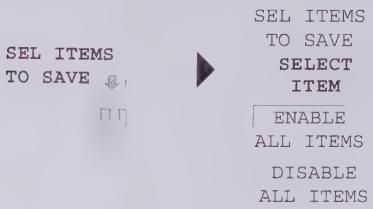
PAGE UP

The *PAGE UP* or *PAGE DOWN* softkey sets the *DATA SET LIST* table to the next or previous page.

PAGE DOWN

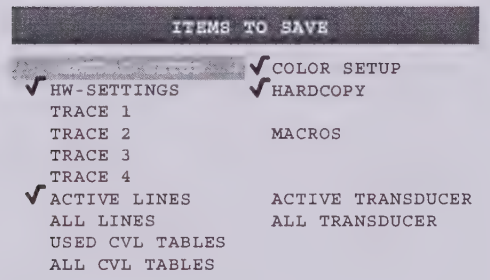
Selecting the Data subset for Storage

MEMORY SAVE-SELECT ITEMS TO SAVE sub-menu:



The *SEL ITEMS TO SAVE* softkey opens a sub-menu for selection of the data subsets.

The *ITEMS TO SAVE* table displays the selectable data subsets:



General Setup	current configuration of general instrument parameters
HW-Settings	current measurement hardware settings
Trace1...4	measurement data trace 1 to trace 4
Active Lines	active limit lines
All Lines	all limit lines
Used CVL Tables	activated conversion loss tables
All CVL Tables	all conversion loss tables
Color Setup	user-defined color settings
Hardcopy Setup	configuration for hardcopy output
Macros	macros
Active Transducer	active transducer
All Transducer	all transducer

SELECT ITEMS

The *SELECT ITEMS* softkey moves the selection bar to the first line, left column of the table.

IEC/IEEE-bus commands

```
:MMEMory:SELect[:ITEM]:GSETup ON|OFF
:MMEMory:SELect[:ITEM]:HWSettings ON|OFF
:MMEMory:SELect[:ITEM]:TRACe<1...4> ON|OFF
:MMEMory:SELect[:ITEM]:LINes[:ACTive] ON|OFF
:MMEMory:SELect[:ITEM]:LINes:ALL ON|OFF
:MMEMory:SELect[:ITEM]:CSETup ON|OFF
:MMEMory:SELect[:ITEM]:HCOPy ON|OFF
:MMEMory:SELect[:ITEM]:CVL[:ACTive] ON | OFF
:MMEMory:SELect[:ITEM]:CVL:ALL ON | OFF
:MMEMory:SELect[:ITEM]:SCData ON | OFF
:MMEMory:SELect[:ITEM]:MACRos ON|OFF
:MMEMory:SELect[:ITEM]:TRANsducer ON|OFF
:MMEMory:SELect[:ITEM]:TRANsducer:ALL ON|OFF
```

ENABLE ALL ITEMS

The *ENABLE ALL ITEMS* softkey marks all entries in the *ITEMS TO SAVE*. table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:ALL`

DISABLE ALL ITEMS

The *DISABLE ALL ITEMS* softkey unmarks all entries in the *ITEMS TO SAVE* table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:NONE`

DEFAULT CONFIG

The *DEFAULT CONFIG* softkey establishes the default selection of the data subset to be saved and outputs *DEFAULT* in the *ITEMS* field of the *SAVE DATA SET* table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:DEFault`

Recalling of Data Sets – *RECALL* Key

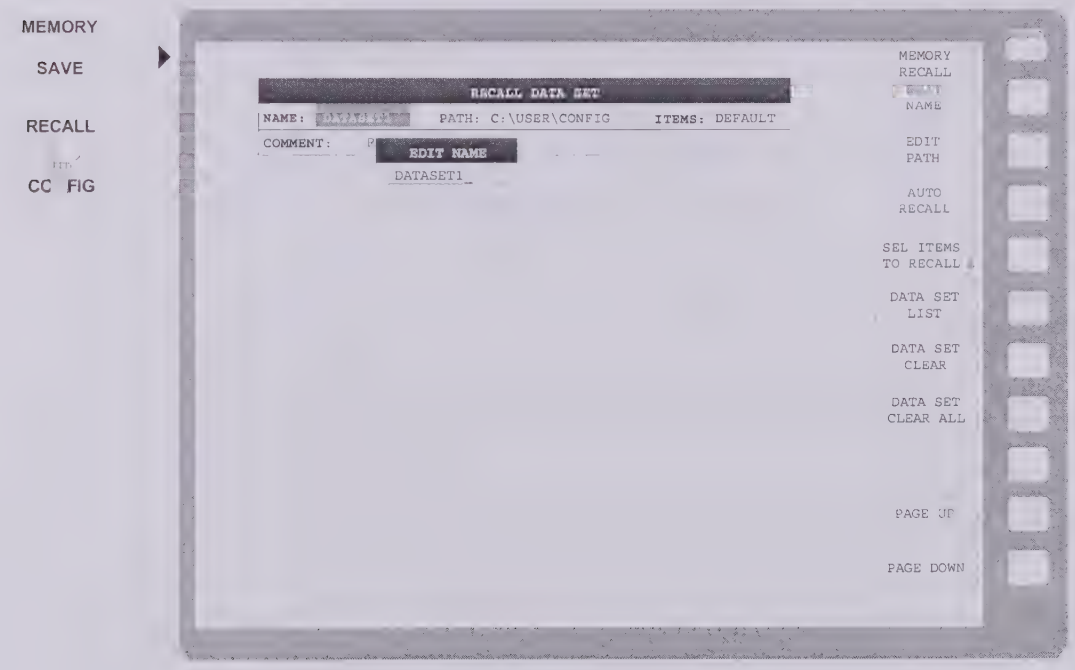
The *RECALL* key activates a menu which contains all functions necessary for recalling data sets.

- Entry of the name of the data set which should be recalled. Confirmation of the entry initiates a load operation to recall the data set.
- Entry of the directory in which the data set is stored
- Display of data set description
- Selection of a data set which will be automatically loaded upon power-up
- Indication of all available data sets
- Deletion of all available data sets
- Selection of the data subsets which should be loaded (configurations, measurement and calibration data, sub-menu SEL ITEMS TO RECALL)

Any settings not restored when data subsets are loaded will remain unchanged in the instrument. During recall operations, the ESI recognises which data subsets are present in the recalled data set and offers only the corresponding settings for selection in the *SELECT ITEM* sub-menu.

A new instrument data set can be easily constructed from several existing data sets: the desired data subsets are selected and recalled out of various data sets in several *RECALL* operations. When the desired configuration is completed, the new data set can be saved under a new name.

MEMORY RECALL menu:



The *RECALL DATA SET* table shows the current settings regarding the data set:

Name	Name of data set
Path	Directory in which the data set is located
Items	Indicates whether the default selection of data subsets (DEFAULT) or a user-defined selection (SELECTED) will be loaded
Comment	Comments about the data set

The *EDIT NAME* softkey for entering the name of the data set to be loaded is activated automatically.

Selecting the Data Set for Recalling

MEMORY RECALL menu:

EDIT NAME

The *EDIT NAME* softkey activates the entry of a data set name.
The data input is terminated by pressing one of the units keys which simultaneously initiates the data set recall operation.

IEC/IEEE-bus command `:MMEMory:LOAD:STATe 1,'A:test'`

EDIT PATH

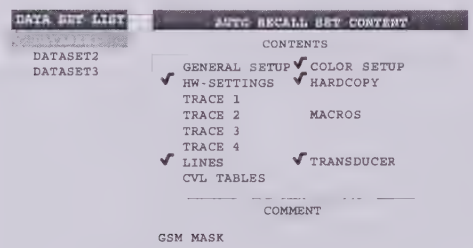
The *EDIT PATH* softkey activates the entry of a directory name in which the data set is located.

IEC/IEEE-bus command `--`

AUTO RECALL

The *AUTO RECALL* softkey activates the selection of a data set which will be automatically recalled when the instrument is powered up. The *DATA SET LIST/CONTENT* table is opened to make the selection (analogous to *DATA SET LIST).*

IEC/IEEE-bus command
`:MMEMory:LOAD:AUTO 1,'C:\user\data\auto'`



The *DATA SET LIST* column displays all the data sets in the selected directory.

The *CONTENTS* and *COMMENT* lines in the *AUTO RECALL CONTENTS* column indicate the saved data subsets and the comments for the currently selected data set.

In addition to the data sets saved by the user, the data set *FACTORY*, which contains the settings of the instrument before it was last switched off (Standby), is always included.

If a data set other than *FACTORY* is chosen the data subsets in the selected data set that are available are recalled when the ESI is powered up. The data subsets which are not in this data set are taken from the *FACTORY* data set.

Note: *The selected data set is also loaded on PRESET if AUTO RECALL is active. The preset settiongs can then be configured as required.*

DATA SET LIST

see Chapter "Saving Data Sets"

DATA SET CLEAR

see Chapter "Saving Data Sets"

DATA SET CLEAR ALL

see Chapter "Saving Data Sets"

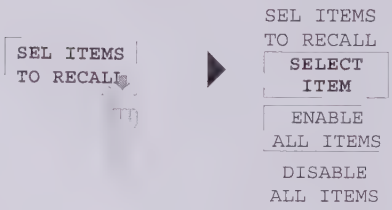
PAGE UP

PAGE DOWN

The *PAGE UP* or *PAGE DOWN* softkey sets the *DATA SET LIST* table to the next or previous page.

Building a Data Set

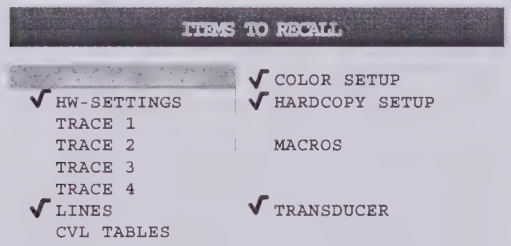
MEMORY RECALL-SELECT ITEMS TO RECALL sub-menu:



The *SEL ITEMS TO RECALL* softkey opens a sub-menu to select data subsets.

DEFAULT
CONFIG

The *ITEMS TO RECALL* table displays the selectable data subsets:



General Setup	current configuration of general instrument parameters
HW-Settings	current measurement hardware settings
Trace1...4	measurement data trace 1 to trace 4
Lines	data point tables for the active limit lines
CVL Tables	conversion loss tables
Color Setup	user-defined color settings
Hardcopy Setup	configuration for hardcopy output
Macros	macros
Transducer	transducer factor, transducer set

SELECT ITEMS

The *SELECT ITEMS* softkey activates the *ITEMS TO RECALL* table and sets the selection bar to the first line, left column of the table.

IEC/IEEE-bus command see "Selecting the Data subset for Storage"

ENABLE ALL ITEMS

The *ENABLE ALL ITEMS* softkey marks all entries in the *ITEMS TO RECALL* table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:ALL`

DISABLE ALL ITEMS

The *DISABLE ALL ITEMS* softkey unmarks all entries in the *ITEMS TO RECALL* table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:NONE`

DEFAULT CONFIG

The *DEFAULT CONFIG* softkey establishes the default selection of the data subset to be recalled and outputs *DEFAULT* in the *ITEMS* field of the *RECALL DATA SET* table.

IEC/IEEE-bus command `:MMEMory:SELect[:ITEM]:DEFault`

Macros – *USER Key*

The ESI menus are so designed that the receiver can be easily applied to most of the usual measurement tasks with a minimum number of key operations. However, the *USER* menu also permits a tailored adaptation of any necessary setup and measurement functions needed for special applications. Here, a sequence of key operations, which may occur repeatedly, can be listed in the *USER* menu as a key macro, then stored in memory and recalled as required by the application.

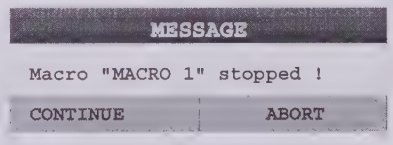
Fundamentals

Macros are defined as arbitrary key sequences which need to be defined only once and then can be recalled as often as desired. Through the use of macros, often-needed measurement functions or instrument setups, which may require a large number of key operations, can be easily performed. The writing of macros is possible only under manual control. Macro generation is not possible under remote control (e.g. via the IEC Bus interface).

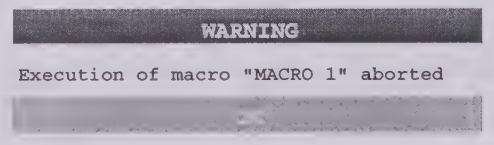
A total of 7 different macros can be programmed and assigned to the individual softkeys of the *USER* menu. Each macro has a title (arbitrarily defined by the user) which is also used as a label for the corresponding softkey. To indicate that a macro has not yet been programmed, the soft-key label appears in parenthesis (e.g. (MACRO 1)). After a key-sequence macro has been defined, the parenthesis are removed and the softkey is replaced by the titel specified by the user.

A macro is executed by pressing the corresponding softkey.

During execution of macros, the key actions are repeated in exactly the **same sequence** as they were programmed. The sequential execution of a macro may be interrupted by using the PAUSE instruction. As soon as a macro is interrupted, adjustments on the Unit Under Test (UUT) may be made, etc. The interrupted macro is allowed to continue by pressing *CONTINUE i*n the message window and is aborted by pressing ABORT.



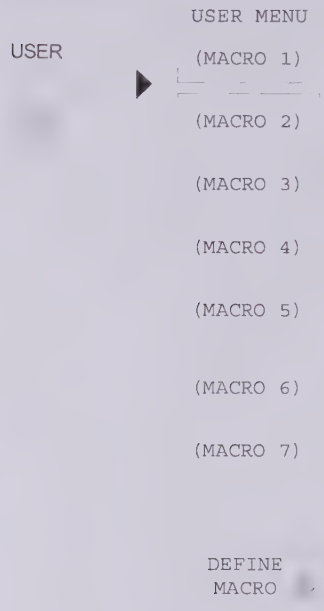
A running macro can be aborted by pressing the *LOCAL* key. At this time, the following message is displayed:



During the time a macro is executing, manual operations on the instrument are not possible, and the soft-key panel is disabled. After interruption or conclusion of a macro, the applicable soft-key panel is enabled (i.e., menu state at the conclusion of the macro).

Starting Macros

USER menu



The USER key opens a menu for selection and starting of macros. The macros can be defined in the *DEFINE MACRO* submenu.

(MACRO 1)

The *MACRO 1* to *7* softkeys start the execution of the macros.

IEC/IEEE-bus command - -

⋮

(MACRO 7)

Defining Macros

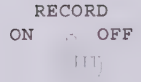
In the *DEFINE MACRO* menu, all necessary softkeys needed for macro management are available. Included are functions for starting and ending macro programming, editing of a macro title, etc.

USER DEFINE MACRO menu

The *DEFINE MACRO* softkey calls the sub-menu to define the macros.

The *SELECT MACRO* softkey is active and opens the box to select the macro to be edited. In case no selection is made, *MACRO 1* is automatically selected.

IEC/IEEE-bus command - -



The *RECORD ON/OFF* starts or stops the recording of the macro.

ON All key actions are recorded until the softkey is changed to *OFF* . To indicate that macro record is enabled, the enhancement label **MAC** is displayed.

The number of actions which can be stored in a macro is limited. If the limit is exceeded, the error message "Macro too long. Recording aborted" is output and the recording operation is aborted, however, the actions already recorded do remain stored.

OFF The recording is stopped. The key actions are stored under the macro chosen by the *SELECT MACRO* softkey.

IEC/IEEE-bus command - -

DEFINE PAUSE

The *DEFINE PAUSE* softkey inserts a pause instruction into the macro sequence which is being recorded. A running macro will pause when it reaches this instruction, at which point settings on the unit under test could for example be made. *CONTINUE* in the message window is used to continue the macro execution.

IEC/IEEE-bus command --

DELETE MACRO

The *DELETE MACRO* softkey deletes the macro which was previously selected by the *SELECT MACRO* softkey. The softkey of the deleted title now carries its default label (*MACRO X*, X = macro number)

IEC/IEEE-bus command --

MACRO TITLE

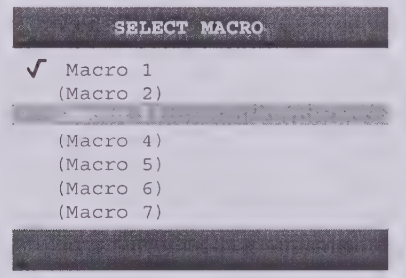
The *MACRO TITLE* softkey activates the entry of the title for the selected macro.

Because the macro title is used for labelling the corresponding softkey, a maximum of only 20 characters is allowed. All text after the 10 th character is written to the second line. However, entering the character @ forces a new line at any point in the softkey title.

IEC/IEEE-bus command --

SELECT MACRO

The *SELECT MACRO* softkey open the selection box with a list of all 7 macros. All soft-key functions of this menu are related to this macro.



IEC/IEEE-bus command --

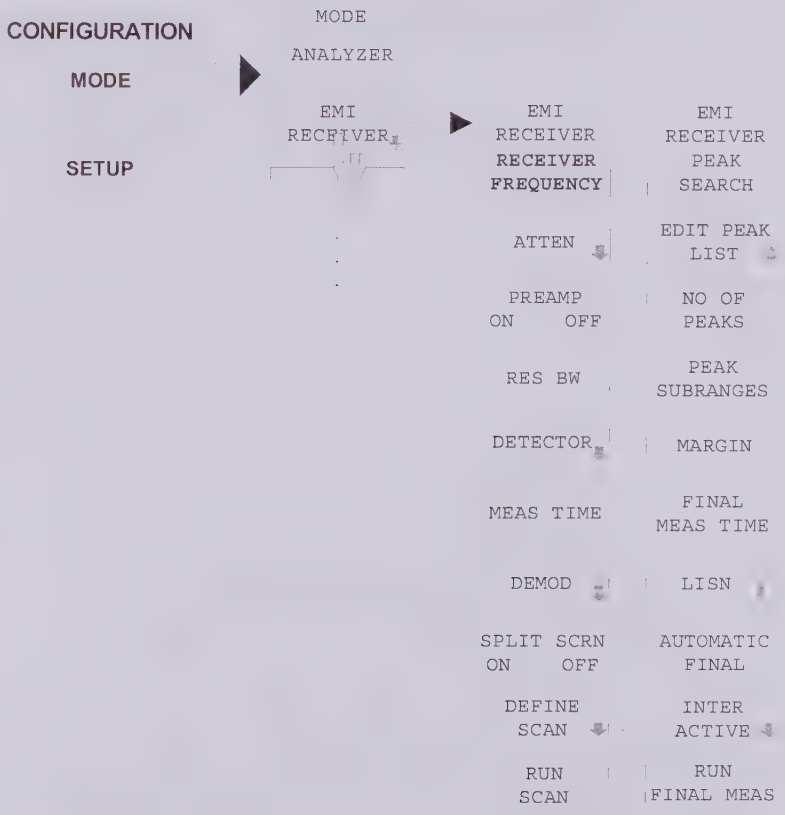
EMI RECEIVER Mode

The mode is selected in the *CONFIGURATION MODE* menu (see also section, Mode Selection - Mode Key)

The *EMI RECEIVER* softkey selects the receiver mode (RFI reception) and activates the menu for setting the receiver parameters.
A window for receiver operation is opened.

The entry for the receiver frequency is automatically active (*FREQUENCY* softkey).

EMI RECEIVER is the default setting of ESI.



IEC/IEEE-bus command `:INSTrument[:SELect] RECeiver`

In the receiver mode, ESI acts as a test receiver, ie it measures the level at the set frequency with a selected bandwidth and measurement time (*RES BW* and *MEAS TIME* softkeys). Signal weighting is by means of the average, max peak, min peak, RMS and quasi-peak detectors (*DETECTOR* softkey).
The attenuation of the employed input can be selected (*ATTEN* softkey). The total noise figure can be reduced by means of a preamplifier (*PRAMP ON/OFF* softkey).
The functions for the control of line impedance simulating network are available in the *SETUP* menu.

A frequency scan can be performed after setting the start and stop frequency and the step width. The scan subranges can be defined in a table (*DEFINE SCAN* softkey). The entry of standard-conformal frequency ranges and associated receiver settings are facilitated by default settings (softkeys *CISPR RANGE A...D*).

The scan is started with the *SCAN* softkey or the *RUN* key in the *SWEEP* field.

To reduce the amount of data in RFI voltage measurements, a list of subrange maxima (softkey *PEAK LIST*) can be generated from the scan results and an acceptance line (softkey *MARGIN*) may be defined. A final measurement is performed only for frequencies with high RFI level.
The final measurement may be either automatic (softkey *AUTOMATIC FINAL*) or in interactive mode (softkey *INTERACTIVE*). Automatic control functions for line impedance stabilization networks (softkey *LISN*) are available. The final measurement is started with the softkey *RUN FINAL MEAS*.

The measurement examples given in section 2 serve as introduction into the different fields of application of the EMI test receiver.

When the EMI receiver mode is active, the *MODE* key directly opens the main receiver menu. For a change to the ANALYZER mode, the main menu must be called first.

Operation on a Discrete Frequency

Setting the Receive Frequency

CONFIGURATION MODE - EMI RECEIVER menu

RECEIVER FREQUENCY

The *RECEIVER FREQUENCY* softkey activates the entry field of the receive frequency.

The receive frequency can also be activated with the *FREQ* key in the *FREQUENCY* field without quitting the currently selected menu. A precondition is that the frequency and level display is active.

The adjustable frequency range depends on the selected input:

Input 1: $20\ Hz \leq f_{in} \leq f_{max}$
Input 2: $20\ Hz \leq f_{in} \leq 1\ GHz$

When the tuning frequency is lower than twice the IF bandwidth, the IF bandwidth is automatically reduced so that this condition is met again.
If the frequency is increased again, the original IF bandwidth is restored. The memory is cleared when the IF bandwidth is manually changed.

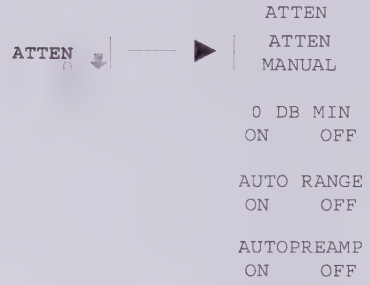
The resolution of the receive frequency is always 0.1 Hz.

IEC/IEEE-bus command `:[SENSe:]FREQuency[:CW|FIXed] <num_value>`

Setting the RF Attenuation

ESI is equipped with two signal inputs selectable in the *INPUT* menu. With INPUT 1 selected the RF attenuation can be set between 0 and 70 dB in 10 dB steps. With INPUT 2 - this is the pulse-resistant input - the attenuation can be set between 0 and 70 dB in 5 dB steps.

CONFIGURATION MODE - EMI RECEIVER menu



The *ATTEN* softkey opens a submenu where the input attenuator can be configured. The submenu includes setting the RF attenuation and the autorange function.

The *RF ATTEN MANUAL* softkey activates the attenuation entry field.

The following attenuation can be set depending on the active input:

- INPUT 1: 0 to 70 dB in 10 dB steps,
- INPUT 2: 0 to 70 dB in 5 dB steps..

Other entries are rounded to the next higher integer.

IEC/IEEE-bus command

```
:INPut:ATTenuation <numeric_value>
```

0 DB MIN
ON OFF

The *0 DB MIN* softkey determines whether the 0 dB setting of the attenuator may be used in the manual or automatic setting of the attenuator.

0 DB MIN OFF is the default value, ie an RF attenuation of at least 10 dB is always set on ESI to protect the input mixer.

An attenuation of 0 dB cannot be set manually either. This avoids 0 dB being switched on inadvertently particularly when DUTs with high RFI voltage are measured.

Caution:

If 0 dB RF attenuation is used with autoranging, care must be taken that the permissible signal level at the RF input is not exceeded. Exceeding this level would damage the input mixer. The 0 dB attenuation should under no circumstances be used when RFI voltage measurements are performed with artificial networks as in this case very high pulses occur during phase switching.

C/IEEE-bus command
`:INPut:ATTenuation:PROTection ON | OFF`

AUTO RANGE
ON OFF

The *AUTO RANGE ON/OFF softkey* switches the autorange function on and off.

With the autorange function active, ESI automatically sets the attenuation so that a good S/N ratio is obtained without the receiver stages being overdriven.

IEC/IEEE-bus command
`:INPut:ATTenuation:AUTO ON | OFF`

AUTOPREAMP
ON OFF

The *AUTOPREAMP ON/OFF* softkey switches the autopreamp function and or off.

With the autopreamp function active, the preamplifier is considered in the autorange procedure. The preamplifier is cut in when the RF attenuation is reduced to the minimum settable value.

IEC/IEEE-bus command `:INPut:GAIN:AUTO ON | OFF`

Preamplifier

In the frequency range up to 7 GHz, ESI is provided with a switchable preamplifier of 20 dB gain.
Switching on the preamplifier reduces the total noise figure of ESI and thus improves the sensitivity. The disadvantage of a poorer large-signal immunity (intermodulation) is reduced by the connected preselector. The signal level of the subsequent mixer is 20 dB higher so that the maximum input level is reduced by the gain of the preamplifier. The total noise figure of ESI is reduced from approx. 18 dB to approx. 10 dB when a preamplifier is used. The use of the preamplifier is recommended when measurements with a maximum sensitivity are to be performed. On the other hand, if the measurement should be performed at maximum dynamic range, the preamplifier should be switched off.
The gain of the preamplifier is automatically considered in the level display. The preamplifier follows the preselection filters so that the risk of overdriving by strong out-of-band signals is reduced to a minimum.

CONFIGURATION MODE - EMI RECEIVER menu

PREAMP
ON OFF

The *PREAMP ON/OFF* softkey switches the preamplifier on and off.

IEC/IEEE-bus command `:INPut:GAIN:STATe ON | OFF`

Setting the IF Bandwidth

ESI offers the IF bandwidths (6 dB bandwidths) 10 Hz, 100 Hz, 200 Hz, 1 kHz, 9 kHz, 10 kHz, 100 kHz, 120 kHz, 1 MHz and 10 MHz.

The IF filters up to 1 kHz are digital Gauss filters. They behave like analog filters.

The 9 kHz and 10 kHz bandwidths are obtained by decoupled crystal filters and the bandwidths between 100 kHz and 1 MHz by decoupled LC filters. These filters contain 5 filter circuits.
The 10 MHz filter is a critically coupled LC filter.

CONFIGURATION MODE - EMI RECEIVER menu

RES BW

The *RES BW* softkey activates the manual entry mode for the resolution bandwidth.

For numerical inputs, the values are always rounded to the next valid bandwidth. For rollkey or the UP/DOWN key entries, the bandwidth is adjusted in steps either upwards or downwards.
When the quasi-peak detector is switched on, a fixed bandwidth is preset depending on the frequency. However, the coupling of the IF bandwidth to the frequency range can be cancelled using softkey *QP RBW UNCOUPLED*.

The bandwidth is limited by the set receive frequency:

$RES\ BW \leq f_{in}/2$

IEC/IEEE-bus command

`:[SENSe:]BANDwidth:RESolution <num_value>`

Selecting the Detector

The ESI detectors are all-digital. Five different detectors can be selected for weighting the receive signal. If ESI is equipped with option ESI-B1, Linear Video Output, the *AC VIDEO* detector has been added to those already available.
The input signal of ESI can be displayed weighted by five detectors.

Peak detectors (*MAX PEAK/ MIN PEAK*)

Peak detectors are implemented with digital comparators, which determine the largest sample values (max peak) or the smallest sample values (min peak) of the levels measured during the set measurement time.

Quasi-peak detector (*QUASIPEAK*)

The quasi-peak detector yields the maximum detected value weighted to CISPR 16 during the set measurement time.
For this purpose ESI uses the linear display voltage after envelope detection. The linear sampling values are weighted with a digital detector. The time constants defined for the bands A, B and C/D are automatically set as a function of the receive frequency.
With switched-on quasi-peak detector, a fixed bandwidth is preset as a function of frequency.

	Band A	Band B	Band C/D
Frequency range	< 150 kHz	150 kHz to 30 MHz	> 30 MHz
IF bandwidth	200 Hz	9 kHz	120 kHz
Charge time constant	45 ms	1 ms	1 ms
Discharge time constant	500 ms	160 ms	550 ms
Time constant of instrument	160 ms	160 ms	100 ms

For frequencies above 1 GHz, ESI uses the settings of band C/D.

The coupling of the IF bandwidth to the frequency range with activated quasi peak detector can be cancelled using the *QP RBW UNCOUPLED* softkey.
If the coupling is cancelled, any of the three CISPR bandwidths 200 Hz, 9 kHz, 120 kHz can be selected for a given frequency range (softkey RES BW).

Average detector (*AVERAGE*)

The average detector yields the average level of the samples measured during the set measurement time.
The ESI uses the linear display voltage after envelope detection. The linear sample values are summed and the sum is divided by the number of measurement samples (= linear average value). In the case of logarithmic display, the logarithm is then formed from the average value.
The average detector gives the true average of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or pulse signal).

RMS detector
(*RMS*)

The rms detector yields the rms level of the samples measured during the set measurement time.
The ESI uses the linear display voltage after envelope detection. The linear samples are squared, summed and the sum is divided through the number of samples (= mean of square). In the case of logarithmic display, the logarithm is then formed from the square sum.
The rms detector gives the true power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or pulse signal). There is no need for the various waveform correction factors which are required when other detectors are used to measure power,

AC Video detector
(*AC VIDEO*,
with option ESI-B1 only)

The AC video detector yields the difference (max peak – min peak) of measurement results over a pixel or a result.
For this purpose ESI uses the linear display voltage after envelope detection. The max peak detector and the min peak detector determine the maximum and minimum levels within a shown measurement point and display it as a common measurement result. For logarithmic representation, the logarithm of the difference is formed. For linear representation, the difference itself is shown. In receiver operation, the AC value determined during the measurement time is shown.
Irrespective of the signal form (CW carrier, modulated carrier, white noise of pulsed signal), the AC video detector always supplies the AC component of the signal.
If during a frequency sweep the dwell time on a certain frequency point is not sufficient, this may lead to incorrect results being displayed.

CONFIGURATION MODE - EMI RECEIVER menu:

DETECTOR

MAX PEAK

QUASIPEAK

AVERAGE

RMS

MIN PEAK

AC VIDEO

QP RBW COUPLED

The *DETECTOR* softkey opens a submenu to select the detector.

Multiple detection is activated by switching on up to four single detectors. The MIN PEAK, RMS and AC VIDEO detector cannot be switched on simultaneously.

Softkey AC *VIDEO* is available only if the instrument is equipped with the linear video output (option ESI-B1).

MAX PEAK

The *MAX PEAK* softkey activates the max peak detector.

IEC/IEEE-bus command
`:[SENSe:]DETector:RECeiver[:FUNCtion] POSitive`

QUASIPEAK

The *QUASIPEAK* softkey selects the quasi-peak detector..

The quasi-peak detector yields the maximum detected value weighted to CISPR 16 during the set measurement time. The IF bandwidth is adapted as a function of the frequency range. The coupling of the IF bandwidth to the frequency range can be cancelled using softkey *QP RBW UNCOUPLED*.

IEC/IEEE-bus command
`:[SENSe:]DETector:RECeiver[:FUNCtion] QPEak`

AVERAGE

The *AVERAGE* softkey activates the average detector.

The average detector supplies the straight average of the signal during the measurement time.

IEC/IEEE-bus command
`:[SENSe:]DETector:RECeiver[:FUNCtion] AVERage`

RMS

The *RMS* softkey activates the rms detector.

The rms detector supplies the rms value of the signal. To this effect the root mean square of all sampled values is formed during the measurement time.

IEC/IEEE-bus command
```
:[SENSe:]DETector:RECeiver[:FUNCtion] RMS
```

MIN PEAK

The *MIN PEAK* softkey activates the min peak detector.

IEC/IEEE-bus command
```
:[SENSe:]DETector:RECeiver[:FUNCtion] NEGative
```

AC VIDEO

The *AC VIDEO* softkey activates the *AC VIDEO* detector.

Irrespective of the signal form, the *AC VIDEO* detector always supplies the AC component of the signal. For this purpose the difference is formed of all maximum and minimum level values collected during the set measurement time. The measurement time therefore determines the number of values to be considered, so the AC component is determined more accurately with increasing measurement time. The *AC VIDEO* detector can thus be used as an alternative for the detection of modulated signals.

IEC/IEEE-bus command
```
:[SENSe:]DETector:RECeiver[:FUNCtion] ACVideo
```

QP RBW UNCOUPLED

The *QP RBW UNCOUPLED* softkey cancels the coupling of the IF bandwidth to the frequency range with activated quasi peak detector.
If the coupling is cancelled, any of the three CISPR bandwidths 200 Hz, 9 kHz, 120 kHz can be selected for a given frequency range (softkey RES BW).

IEC/IEEE-bus command
```
:[SENSe:]BANDwidth[:RESolution]:AUTO ON|OFF
```

Setting the Measurement Time

The measurement time is the time during which ESI measures the input signal and forms a measurement result weighted by the selected detector. The measurement time does not include settling times. ESI automatically waits until transients are over.

CONFIGURATION MODE - EMI RECEIVER menu

`MEAS TIME`

The *MEAS TIME* softkey activates the entry field for the measurement time.

The measurement time can be set in steps of 1-2-5 in the range 100 µs to 100 s. A measurement time of 15 s is available in addition.

When the quasi-peak detector is used, the minimum measurement time is 1 ms.

With the average, RMS, AC video or min/max peak detector the smallest settable measurement time depends on the bandwidth.

Bandwidth	Shortest measurement time AV, RMS	Shortest measurement time PK+, PK-, AC video
≤ 10 Hz	1 s	10 ms
100 Hz	100 ms	1 ms
200 Hz	50 ms	1 ms
1 kHz	10 ms	0.1 ms
9 kHz	1 ms	0.1 ms
≥ 100 kHz	0.1 ms	0.1 ms

IEC/IEEE-bus command `:[SENSe:]SWEep:TIME <numeric_value>`

Effect of measurement time with different weighting modes:

MIN/MAX PEAK measurement:

With peak weighting selected, the maximum or minimum level during the selected measurement time is displayed. The peak detector is reset at the beginning of each measurement. At the end of the measurement time the maximum or minimum level occurred during the measurement time is displayed. Since the peak detector of ESI is a digital detector, discharging is irrelevant even with long measurement times.
Unmodulated signals can be measured with the shortest possible measurement time. When pulses are measured, the selected measurement time must be long enough for at least one pulse to occur during the measurement time.

AC video measurement:

Since the AC video detector is a combination of a min peak and a max peak detector, the considerations for the peak measurement apply here too
The longer the measurement time, the better the acquisition of the AC voltage component of the test signal.

Quasi-peak measurement:

With quasi-peak measurements, the maximum value of the weighted signal during the measurement time is displayed. The relatively long time constants used with quasi-peak detectors entail long measurement times to obtain correct results. With unknown signals the measurement time should be at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
After internal switching, ESI waits until the measurement result has stabilized before it starts the actual measurement. Since the level does not change during a frequency scan, known signals (eg broadband RFI) can be correctly measured with a much shorter measurement time.

Average measurement:

With average detection selected, the video voltage (envelope of IF signal) is averaged during the measurement time. Averaging is digital, ie the digitized values of the video voltage are summed up and divided by the number of samples at the end of the measurement time. With unmodulated signals the shortest possible measurement time can be selected. With modulated signals the measurement time is determined by the lowest modulation frequency to be averaged. With pulse signals, the selected measurement time should be long enough for sufficient number of pulses (>10) to occur in the measurement window for averaging.

RMS measurement:

With RMS weighting the same applies to the measurement time as with the average measurement.

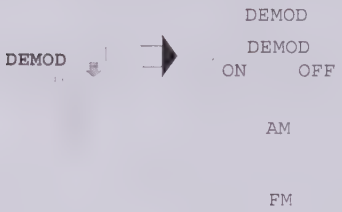
Measurement with several detectors:

If several detectors are used simultaneously, a measurement time suiting the slowest detector should be selected to obtain correct results for all detectors. It is therefore recommended to set a measurement time that matches the average detector when the peak and average detectors are used.

AF Demodulators

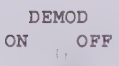
ESI provides demodulators for AM and FM signals. With these demodulators selected, a displayed signal can be monitored using the internal loudspeaker or external headphones.

CONFIGURATION MODE - EMI RECEIVER menu:



The *DEMOD* softkey calls a submenu in which the desired type of demodulation can be switched on.

The volume for loudspeaker and headphones is set by means of control knob on the front panel. When the knob is in the *Remote* position (left stop) the volume can be remote-controlled.



The *DEMOD ON/OFF* softkey switches demodulation on/off. When demodulation is on, the signal is demodulated.

IEC/IEEE-bus command `[SENSe:]DEMod OFF`
(DEModulation ON automatically switched on with AM|FM)

The *AM* and *FM* selection switches can be activated one at a time. They are used to set the desired demodulation type, FM or AM. The default setting is AM.

IEC/IEEE-bus command `:[SENSe:]DEMod AM | FM`

Switchover between Full Screen and Split Screen Mode

CONFIGURATION MODE - EMI RECEIVER menu:

The *SPLIT SCRN ON/OFF* softkey toggles between full-screen and split-screen mode.

During the scan ESI automatically selects full-screen mode.

IEC/IEEE-bus command --

Frequency Scan

In the scan mode, ESI measures in a predefined frequency range with selectable step width and measurement time for each frequency.
Up to 10 subranges which need not be next to each other can be defined within one scan. The subranges are then scanned by ESI one after the other. Measurement ranges should not overlap. The parameters to be measured in each subrange can be selected independently.

Transducer factors or transducer sets and limit lines can be defined and displayed separately and are not part of the scan data record.

The scanned frequency range is defined by the start and stop frequency set independently of the scan table. A scan table can thus be defined for each measurement task, which can be stored and reloaded. The required frequency range can be defined by means of two parameters which can be set via keys so that no elaborate editing has to be done in the scan table.

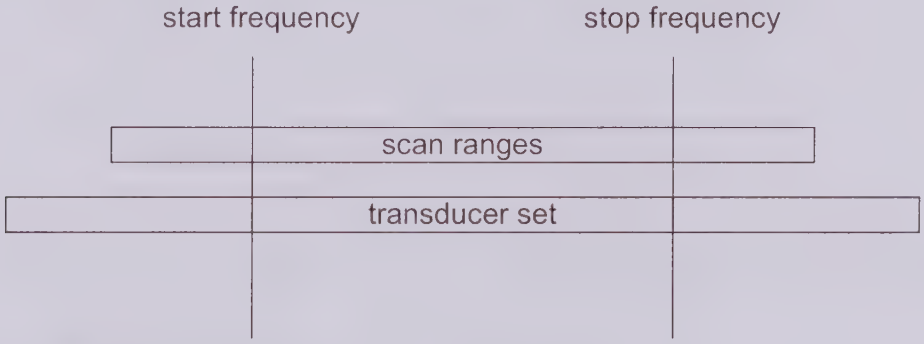


Fig. 4-6 Definition of scan range

Full-screen or split-screen mode can be selected for result display. In the full-screen mode, the result diagram covers the whole screen area.

In split-screen mode, the upper half of the screen displays either the frequency and level readout, ie a bargraph or the spectrum analyzer screen with frequency sweep or zero span. The lower half holds the result diagram possibly with the previously measured scan results.

In the split-screen mode, the upper half of the screen is used for frequency and level readout. The diagram is displayed in the lower half. During the scan ESI automatically selects full-screen display.

Up to 4 detectors can be measured simultaneously. They are assigned to traces 1 to 4. Since the detectors are set only once, it is not possible to measure with different detectors in different the subranges.

The scan can be performed as a single scan or continuously. Scanning is started with the *RUN SCAN* softkey and in the case of single scan it is stopped when the stop frequency is reached. The continuous scan can be interrupted with the *HOLD SCAN* softkey or terminated with *STOP SCAN.*

The maximal number of measured frequencies which can be measured, is limited and depends on the number of the traces which are switched on.

Number of traces	Measured values /trace
1	250.000
2	150.000
3	100.000
4	80.000

They are stored for postprocessing. If the scan subranges are defined so that more than the possible values would be measured, a respective message is output upon the scan start. Afterwards the scan is performed up to the maximum value.

In the *DEFINE SCAN* menu predefined settings of standard-conformal frequency ranges and associated receiver settings can be selected (softkeys *CISPR RANGE A...D*)

Entry of Scan Data

A scan is defined in the form of tables. Each scan range is determined by the start frequency, stop frequency, step width and by the measurement parameters valid for the range. Frequency and level axes can be user-selected and are defined for the whole scan.

The *DEFINE SCAN* softkey opens a submenu where existing scan tables can be edited or new ones created. Tables with the current scan settings are displayed.

Pressing the *SCAN* key in the *SWEEP* field also opens the *DEFINE SCAN* submenu.

The *SCAN* table at the top specifies limit frequencies for the diagram, linear or logarithmic frequency switching and the display mode for the frequency axis.

The *SCAN RANGES* table at the bottom gives settings for the scan subranges. It contains 5 columns for 5 subranges and lines for entering the parameters for the different subranges. Up to 10 subranges can be defined.

At least one scan is defined in the list. Two subranges with the limit frequencies 150 kHz and 30 MHz and 30 MHz and 1 GHz are defined in the default setup. All other parameters are shown in the following table:

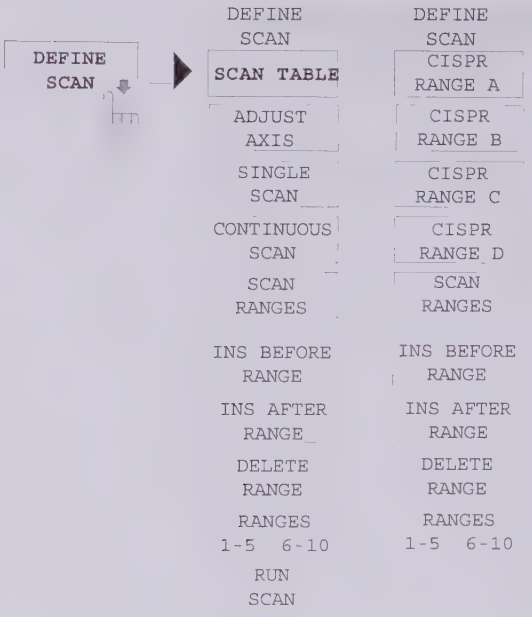
Table 4-3 Default setup of scan table

	Range 1	Range 2
Start frequency	150 MHz	30 MHz
Stop frequency	30 MHz	1 GHz
Step width	4 kHz	40 kHz
IF bandwidth	9 kHz	120 kHz
Measurement time	1 ms	100 µs
Auto ranging	off	off
RF attenuation	10 dB	10 dB
Preamplification	off	off
Auto-Preamp	off	off
Input	Input1	Input1

The diagram parameters to be defined are: start frequency 150 kHz, stop frequency 1 GHz, min. level 0 dBµV, max. level 100 dBµV, linear frequency switching and log. frequency axis.
The measurement parameters correspond to the settings recommended for overview measurements to CISPR 16.

When the menu for creating and editing scans is quit and no runnable scan is available, the last scan data record is activated.

CONFIGURATION MODE - EMI RECEIVER menu



The *DEFINE SCAN* softkey opens a submenu where existing scan tables can be edited or new ones created. Tables with the current scan settings are displayed.

IEC/IEEE-bus command --

Limits for the diagram and the type of frequency switching can be entered in the *SCAN* table .

```
                    SCAN
Start      150 kHz      Max Level      100 dBµV
Stop       1 GHz        Min Level      0 dBµV

Step       LIN Auto     Frequency Axis LOG
```

Start	lower frequency limit
Stop	upper frequency limit
Step	linear or logarithmic frequency switching
Max Level	upper level limit
Min Level	lower level limit
Frequency	linear or logarithmic frequency axis

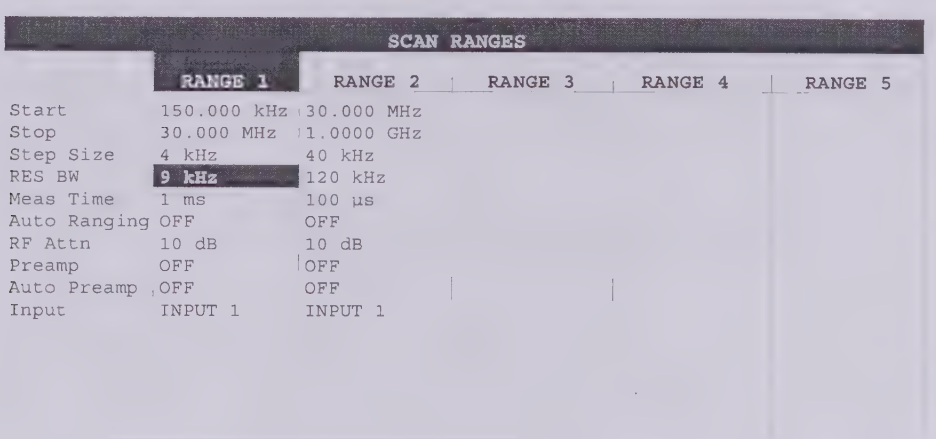
SCAN TABLE

The *SCAN TABLE* softkey activates the entry field for the limits in the *SCAN* table.

IEC/IEEE-bus commands

```
:[SENSe:]FREQuency:STARt <num_value>
:[SENSe:]FREQuency:STOP  <num_value>
:[SENSe:]SWEep:SPACing  LIN | LOG | AUTO
:DISPlay:TRACe:Y[:SCALe]:TOP <num_value>
:DISPlay:TRACe:Y[:SCALe]:BOTTom <num_value>
:DISPlay:TRACe:X:SPACing  LIN | LOG
```

In the *SCAN RANGES* table the parameters for the individual subranges can be set.



Start

Entry of start frequency
The following conditions should be observed:
The start frequency of a subrange must be equal to or greater than the stop frequency of the previous subrange. The start frequency of the next subrange must always be greater than the stop frequency of the already defined one.
When the start frequency is entered, the entry field for the stop frequency is automatically activated.

Stop

Entry of stop frequency
The following conditions should be observed:
The stop frequency of a subrange must be equal to or greater than the start frequency of the subrange. The stop frequency of a subrange must always be lower than the start frequency of the next subrange.

When start and stop frequencies are entered, the adjacent subranges are automatically adapted to ensure that the above-mentioned conditions are met.

Step Size

Entry of step size
In the case of linear frequency increments, step widths between 1 Hz and the maximum ESI frequency can be set. When a step size greater than the scan range is entered (from start to stop), ESI performs a measurement at the start and stop frequency.
With logarithmic frequency increments, values between 0.1% and 100% can be set with steps of 1/2/3/5.
With *STEP AUTO* selected, the step size cannot be changed because it is automatically set with respect to the IF bandwidth.

RES BW

Entry of IF bandwidth
In the case of quasi-peak weighting, usually a fixed bandwidth is set which cannot be changed (CISPR). However, the coupling of the IF bandwidth to the frequency range can be cancelled using softkey *QP RBW UNCOUPLED* in the *MODE EMI RECEIVER* menu.

Meas Time

Entry of measurement time
The measurement time can be set between 100 µs and 100 s separately for each subrange.

Auto Ranging

Activates the autorange function
With automatic attenuation setting selected, ESI automatically sets the input attenuation as a function of the signal level.

Caution:

If 0 dB RF attenuation is used with autoranging, care must be taken that the permissible signal level at the RF input is not exceeded. Exceeding this level would damage the input mixer. The 0 dB attenuation should under no circumstances be used when RFI voltage measurements are performed with the aid of artificial networks as in this case very high pulses occur during phase switching.

RF Atten

Entry of a fixed RF attenuation

Preamp

Switching the preamplifier on and off

Auto Preamp

Activates the auto preamp function
The preamplifier is considered in autoranging. It is only cut in after the attenuation has been reduced to the minimum settable value.

Input

Selection of RF input

ADJUST AXIS

The *ADJUST AXIS* softkey automatically sets the limits of the diagram so that the lower limit frequency corresponds to the start frequency of range 1 and the upper limit frequency to the stop frequency of the last range.

IEC/IEEE-bus command --

SINGLE SCAN

Pressing the *SINGLE SCAN* softkey triggers a frequency scan. ESI stops at the end frequency.

The enhancement label SGL displayed at the screen edge indicates that the single-scan mode is set.

IEC/IEEE-bus command :INITiate2:CONTinuous OFF

CONTINUOUS SCAN

The *CONTINUOUS SCAN* softkey selects the continuous scan mode. ESI scans continuously until the scan is stopped.

IEC/IEEE-bus command :INITiate2:CONTinuous ON

SCAN RANGES

The *SCAN RANGES* softkey activates the entry of scan settings in the *SCAN RANGES* table.

IEC/IEEE-bus commands

```
:[SENSe:]SCAN<1..10>:RANGes[:COUNt]  1...10
:[SENSe:]SCAN<1..10>:STARt  <num_value>
:[SENSe:]SCAN<1..10>:STOP  <num_value>
:[SENSe:]SCAN<1..10>:STEP  <num_value>
:[SENSe:]SCAN<1..10>:BANDwidth:RESolution
                                    <num_value>
:[SENSe:]SCAN<1..10>:TIME  <num_value>
:[SENSe:]SCAN<1..10>:INPut:ATTenuation:AUTO
                                    <num_value>
:[SENSe:]SCAN<1..10>:INPut:ATTenuation
                                    <num_value>
:[SENSe:]SCAN<1..10>:INPut:GAIN  <num_value>
:[SENSe:]SCAN<1..10>:INPut:GAIN:AUTO  ON|OFF
:[SENSe:]SCAN<1..10>:INPut:TYPE  INPUT1|INPUT2
```

Editing a Scan

The parameters of a scan subrange in a scan data record can be modified or complete subranges can be added or deleted. When changing the scan limit frequencies, care should be taken that the scan ranges do not overlap.

Complete scan ranges can be cleared or added with the *INSERT RANGE* and *DELETE RANGE* softkeys.

Predefined settings of standard-conformal frequency ranges and associated receiver settings can be selected (softkeys *CISPR RANGE A...D*).

CONFIGURATION MODE - EMI RECEIVER - DEFINE SCAN menu

INS BEFORE RANGE

The *INS BEFORE RANGE* softkey shifts the active scan range in the table to the left by one column. A new column with identical settings is created. The limit frequencies can be changed accordingly.

IEC/IEEE-bus command --

INS AFTER RANGE

The *INS AFTER RANGE* softkey shifts the active scan range in the table to the right by one column. A new column with identical settings is created. The limit frequencies can be changed accordingly.

IEC/IEEE-bus command --

DELETE RANGE

The *DELETE RANGE* softkey clears the activate scan range. All other ranges are shifted to the left by one column.

IEC/IEEE-bus command --

RANGES 1-5 6-10

With the *RANGES 1-5/6-10* softkey a switchover can be made between ranges 1-5 and 6-10.

IEC/IEEE-bus command --

CISPR RANGE A

CISPR RANGE C

CISPR RANGE B

CISPR RANGE D

The *CISPR RANGE A/B/C/D* softkeys enter the following standard-conformal frequency ranges and associated receiver settings into the scan table:

	Band A	Band B	Band C	Band D
Start frequency	9 kHz	150 kHz	30 MHz	300 MHz
Stop frequency	150 kHz	30 MHz	300 MHz	1 GHz
Step width	80 Hz	4 kHz	40 kHz	40 kHz
RBW	200 Hz	9 kHz	120 kHz	120 kHz
MEAS TIME	50 ms	1 ms	100 us	100 us

IEC/IEEE-bus command --

Running a Scan

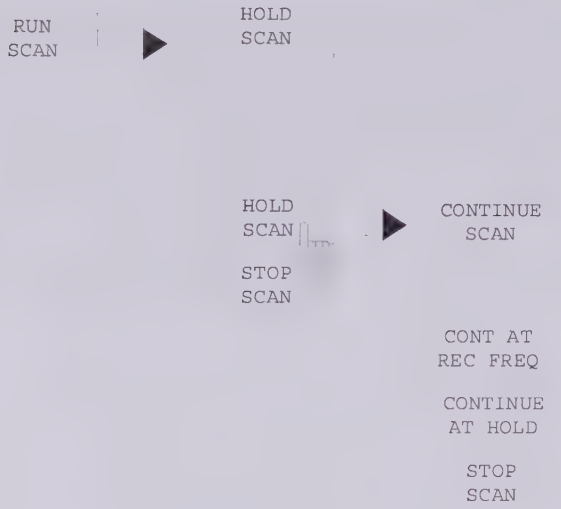
The scan is started with the *RUN SCAN* softkey. It can also be started with the *RUN* key in the *SWEEP* field.
At the beginning of the scan, ESI sets up the diagram as specified in the scan table and starts the scan in the selected mode (*SINGLE* or *CONTINUOUS*). With *SINGLE* selected, ESI performs a single scan and stops at the end frequency. With *CONTINUOUS* selected, the scan is performed continuously until it is deliberately stopped.
The measurement can be interrupted with *HOLD SCAN* or stopped with *STOP SCAN*. The two softkeys are displayed instead of the menu shown before the scan is started.
If a transducer set is defined with points of changeover, the scan automatically stops at the frequencies of the new subrange of the transducer set and the user may exchange the transducer.
The following message informs the user that the limit has been reached:

TDS Range # reached, CONTINUE / BREAK

He can continue the scan at the point of change over by confirming the message (*CONTINUE*) or he can switch off the transducer (*BREAK*).

IEC/IEEE-bus commands `:INITiate2:CONMeas` (CONTINUE)
`--` (BREAK)

CONFIGURATION MODE - EMI RECEIVER menu



The *RUN SCAN* softkey starts the frequency scan with the selected settings. The *HOLD SCAN* submenu is displayed instead of the menu shown before the scan is started.

IEC/IEEE-bus command
`:INITiate2[:IMMediate]`

HOLD SCAN

The *HOLD SCAN* softkey interrupts the scan.

The *CONTINUE SCAN* submenu is displayed. The scan stops at the frequency at which it was interrupted until it is continued with the *CONT AT REC FREQ* or *CONTINUE AT HOLD* softkeys.

While the scan is stopped, the receiver settings can be changed, eg for a detailed analysis of the recorded trace.

IEC/IEEE-bus command `:HOLD`

CONT AT REC FREQ

With the *CONT AT REC FREQ* softkey the scan is continued at the current receiver frequency when the receiver frequency is lower than the frequency at which the scan was interrupted. Otherwise the scan continues at the frequency at which it was interrupted.

IEC/IEEE-bus command `:INITiate2[:IMMediate]`

CONTINUE AT HOLD

With the *CONT AT HOLD* softkey the scan is continued where it was interrupted. The scan is always continued with the settings in the scan table.

IEC/IEEE-bus command --

STOP SCAN

The *HOLD SCAN* softkey stops the scan. Upon restart, scanning starts at the beginning. The results of the performed measurements are lost.

IEC/IEEE-bus command `:ABORt`

Data Reduction and Peak List

EMI measurements may involve much time because the time constants prescribed by the standard for the quasi-peak weighting require transients which lead to long measurement times per each value. In addition, the standards stipulate procedures for finding local EMI maxima such as shifting the absorbing clamp, variation of the test antenna height and rotating the DUT. Measuring with quasi-peak weighting at each frequency and for each setting of the test configuration would lead to unacceptably long measurement times. For this reason, R&S has developed a method which reduces the time-consuming measurements to a minimum with an optimum reliability of detection.

The interference spectrum is first pre-analyzed in a fast prescan to optimize the duration of the measurement. Data reduction follows so that the time-consuming final measurement is performed at only some important frequencies:

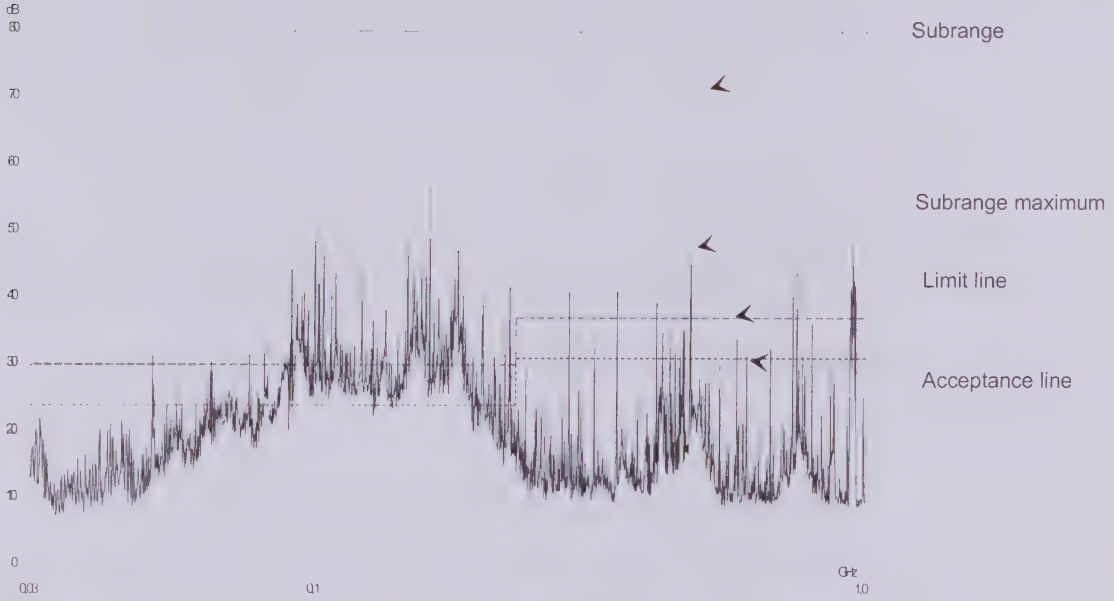


Fig. 4-7 Dividing the spectrum into eight subranges

Data reduction is of crucial importance. It is initiated by the user pressing a key after the prescan and then automatically performed by the receiver. Data reduction is used to select frequencies with a very high interference level. Several data reduction methods are used:

- Acceptance analysis, ie the interference spectrum is further analyzed at frequencies with levels above a line parallel to a limit line.
- Generating subrange maxima, ie the interference spectrum is further analyzed at frequencies with the highest interference level of a frequency subrange (search method SUBRANGES).
- Determination of a specific number of peak values relative to the limit lines with the level values being independent of their frequency spectral distribution (search method PEAKS).

For generation of subrange maxima, the whole frequency range is divided into equidistant subranges. A subrange maximum is determined for each subrange (search method SUBRANGES).
Determining the level maxima irrespective of their distribution in the frequency spectrum (search mode PEAKS) is suitable for measurement regulations that demand determination of the relatively highest level irrespective of the distribution in the measured frequency range, eg FCC.
If the prescan is performed in parallel with several detectors, typically with peak value and average value, the maxima are determined separately for the two detectors so that the distribution of narrowband and wideband sources of interference can be taken into account. For example, the frequency of the maximum determined with the average detector can be used for the final measurement performed with this detector and the frequency found in the prescan carried out with the peak detector is taken for the final measurement using the quasi-peak detector.

Consideration of the limit lines ensures that the final measurement is not performed at frequencies at which the inference level is far below the limit value. The margin between the acceptance line and the limit line can be selected by the user in dB as the *MARGIN*. Each limit line is allocated to a trace, ie different limit lines are taken for the different detectors.
Two values should therefore be defined for this purpose:

- the number of subranges or highest level values (*NO OF PEAKS* in the range from 1 to 500; default value: 25)
- the acceptance margin (*MARGIN*; default value: 6 dB). It is valid for all limit lines.

As an alternative method, it is possible to preset a list of frequencies at which the final measurements are performed. A typical application is, for example, the statistical analysis of several units.
The peak list can be either edited manually or can be filled with desired values by adopting the marker values.

If no limit lines are activated, the measurement procedure is as if all measured values would exceed the limit line.

CONFIGURATION MODE - EMI RECEIVER menu (right side menu)

EMI
RECEIVER
PEAK
SEARCH

EDIT PEAK
LIST

NO OF
PEAKS

PEAKS
SUBRANGES

MARGIN

FINAL
MEAS TIME

LISN

AUTOMATIC
FINAL

INTER
ACTIVE

RUN
FINAL MEAS

The *PEAK SEARCH* softkey starts the determination of the subrange maxima list from the available scan results. The procedure can be repeated as often as desired to try out different settings of margin and number of subranges.

IEC/IEEE-bus command

```
:CALCulate<1|2>:PEAKsearch[:IMMediate]
```

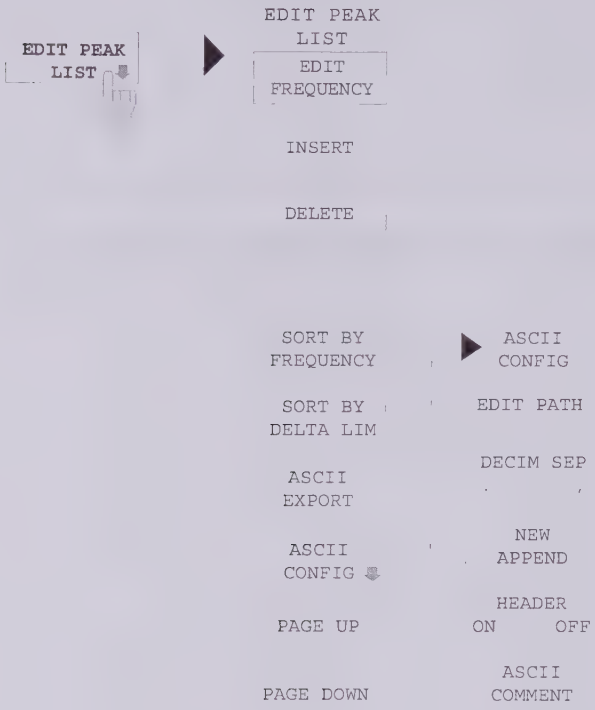
The following table shows the peak list which is determined by the peak-search function after the prescan:

EDIT PEAK LIST (Prescan Results)

Trace1: 014QP Trace2: 014AV
Trace3: --- Trace4: ---

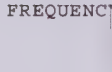
	TRACE	FREQUENCY	LEVEL dBpT	DELTA LIMIT dB
2	Average	80.0000 MHz	35.34	-3.91
2	Average	89.4800 MHz	38.83	-0.91
1	Max Peak	98.5200 MHz	47.53	-2.63
2	Average	98.5200 MHz	46.63	6.47
1	Max Peak	100.7200 MHz	54.14	3.88
2	Average	102.3200 MHz	50.89	10.56
1	Max Peak	113.2400 MHz	49.68	-1.08
2	Average	116.9200 MHz	44.81	3.91
1	Max Peak	125.8800 MHz	55.01	3.78
2	Average	125.8800 MHz	53.55	12.33
1	Max Peak	138.4800 MHz	45.68	-5.95
2	Average	138.4800 MHz	42.17	0.53
2	Average	144.0400 MHz	43.72	1.90
2	Average	167.0400 MHz	44.77	2.32
2	Average	176.2400 MHz	45.52	2.83
1	Max Peak	200.4800 MHz	52.49	-0.75
2	Average	200.4800 MHz	48.76	5.51
1	Max Peak	210.2800 MHz	60.55	7.09
2	Average	226.5600 MHz	59.02	15.24
2	Average	230.0000 MHz	48.59	4.75

CONFIGURATION MODE - EMI RECEIVER menu (right side menu)



The *EDIT PEAK LIST* softkey calls the *EDIT PEAK LIST* submenu used for editing the peak list. A frequency list can thus be predefined and a final measurement carried out at these frequencies.

A peak list can also be generated by adopting the marker values (see section "Changing the device settings with Markers marker →")



The *EDIT FREQUENCY* softkey activates table *EDIT PEAK LIST*. The cursor marks the upper field of column *FREQUENCY*.

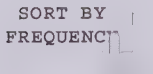
IEC/IEEE-bus command --

The *INSERT* softkey creates an empty line above the current cursor position

IEC/IEEE-bus command --

The *DELETE* softkey erases the complete line at the cursor position. Before deletion, a message appears requesting confirmation..

IEC/IEEE-bus command --



The softkey *SORT BY FREQUENCY* sorts the table in a descending order according the entries in the *FREQUENCY* column.

IEC/IEEE-bus command --

SORT BY DELTA LIM

The softkey *SORT BY DELTA LIMIT* sorts the table in a descending order according to the entries in the *DELTA LIMIT* column (see table below).

IEC/IEEE-bus command --

The following table shows the peak list sorted according to the margin to the limit value list:

EDIT PEAK LIST (Prescan Results)

Trace1: 014QP Trace2: 014AV
Trace3: --- Trace4: ---

TRACE		FREQUENCY	LEVEL dBpT	DELTA LIMIT dB
2	Average	226.5600 MHz	59.02	15.24
2	Average	125.8800 MHz	53.55	12.33
2	Average	102.3200 MHz	50.89	10.56
1	Max Peak	210.2800 MHz	60.55	7.09
2	Average	98.5200 MHz	46.63	6.47
2	Average	200.4800 MHz	48.76	5.51
2	Average	230.0000 MHz	48.59	4.75
2	Average	116.9200 MHz	44.81	3.91
1	Max Peak	100.7200 MHz	54.14	3.88
1	Max Peak	125.8800 MHz	55.01	3.78
2	Average	176.2400 MHz	45.52	2.83
2	Average	167.0400 MHz	44.77	2.32
2	Average	144.0400 MHz	43.72	1.90
2	Average	276.9200 MHz	45.81	1.16
2	Average	138.4800 MHz	42.17	0.53
2	Average	267.2800 MHz	44.44	-0.05
1	Max Peak	200.4800 MHz	52.49	-0.75
2	Average	89.4800 MHz	38.83	-0.91
1	Max Peak	113.2400 MHz	49.68	-1.08
1	Max Peak	98.5200 MHz	47.53	-2.63

ASCII EXPORT

The *ASCII EXPORT* softkey stores the final measurement data in a file with ASCII format.
Upon pressing the ASCII EXPORT softkey, a file name can be entered. The default name is TRACE.DAT. Then the measured data of the trace are stored.
The function can be configured in the *ASCII CONFIG* submenu.

IEC/IEEE-bus command
`:MMEMory:STORe:FINal <Pfad with Filenames>`

ASCII CONFIG

In the *ASCII CONFIG* submenu, various settings for the *TRACE ASCII EXPORT* function can be made (see Section "Trace Selection and Setup").

Structure of the ASCII file:

RECEIVER mode, final measurement data:

	Content of file	Description
File header	Type;ESI 7;	Instrument model
	Version;2.07;	Firmware version
	Date;01.Jan 2000;	Date record storage date
	Mode;Receiver;	Instrument operating mode
	Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz
	x-Axis;LIN;	Scaling of x axis linear (LIN) or logarithmic (LOG)
	Scan Count;1;	Number of scans set
	Transducer;TRD1;	Transducer name (if switched on)
	Scan 1:	Loop over all defined scan ranges (1-10)
	Start;150000;Hz	Range - start frequency in Hz
	Stop;1000000;Hz	Range – stop frequency in Hz
	Step;4000;Hz	Range - step width in Hz for linear step width or in % (1-100) for logarithmic step width
	RBW;100000;Hz	Range - resolution bandwidth
	Meas Time;0.01;s	Range - measurement time
	Auto Ranging;ON;	Auto ranging on - or off for current range
	RF Att;20;dB	Range - input attenuation
	Auto Preamp;OFF;	Auto Preamp on or off for current range
	Preamp;0;dB	Range - preamplifier on (20dB) or off (0dB)
	Input,1;	Range - input (1 or 2)
Data section of the file	TRACE 1 FINAL:	Selected trace
	Trace Mode;AVERAGE;	Trace mode: CLR/WRITE,AVERAGE,MAX HOLD,MIN HOLD, VIEW, BLANK
	Final Detector	Final detector MAX PEAK, MIN PEAK, RMS, AVERAGE, QUASI PEAK, AC VIDEO
	x-Unit;Hz;	Unit of x values:
	y-Unit;dBuV;	Unit of y values:
	Final Meas Time;1.000000;s	Final measurement time
	Margin;6.000000:s	Margin
	Values;8;	Number of test points
	2;154000.000000;81.638535;15.638535;N;GND 1;158000.000000;86.563789;7.563789;N;GND 2;1018000.000000;58.689873;-1.310127;N;GND ...	Measured values: <Trace>;<x-value>, <y-value>; <phase>; <ground> Phase and protective grounding are output only if a line impedance stabilization has been activated. They specify the setting at which the maximum RFI level at the associated frequency was found.

Example :

```
Type;ESI 40 ;
Version;2.08;
Date;30.May 2000;
Mode;Receiver;
Start;150000.000000;Hz
Stop;30000000.000000;Hz
x-Axis;LOG;
Scan Count;1;
Transducer;;
Scan 1:
Start;150000.000000;Hz
Stop;30000000.000000;Hz
Step;4000.000000;Hz
RBW;9000.000000;Hz
Meas Time;0.001000;s
Auto Ranging;OFF;
RF Att;10.000000;dB
Auto Preamp;OFF;
Preamp;0.000000;dB
Input;1;
Scan 2:
Start;30000000.000000;Hz
Stop;1000000000.000000;Hz
Step;40000.000000;Hz
RBW;120000.000000;Hz
Meas Time;0.000100;s
Auto Ranging;OFF;
RF Att;10.000000;dB
Auto Preamp;OFF;
Preamp;0.000000;dB
Input;1;
TRACE 1 FINAL:
Trace Mode;CLR/WRITE;
Final Detector;QUASI PEAK;
TRACE 2 FINAL:
Trace Mode;CLR/WRITE;
Final Detector;AVERAGE;
x-Unit;Hz;
y-Unit;dBuV;
Final Meas Time;1.000000;s
Margin;6.000000;dB
Values;11;
2;154000.000000;81.638535;15.638535;N;GND
1;158000.000000;86.563789;7.563789;N;GND
2;1018000.000000;58.689873;-1.310127;N;GND
2;302000.000000;63.177345;-2.822655;L1;GND
2;3294000.000000;56.523022;-3.476978;N;GND
2;1122000.000000;53.849747;-6.150253;N;GND
2;10002000.000000;47.551216;-12.448784;N;GND
1;3390000.000000;59.762917;-13.237083;N;GND
1;9998000.000000;58.309189;-14.690811;L1;GND
2;20002000.000000;45.142456;-14.857544;L1;GND
2;7502000.000000;36.406967;-23.593033;L1;GND
```

CONFIGURATION MODE - EMI RECEIVER menu (right side menu)

NO OF PEAKS

Der Softkey *NO OF PEAKS* activates the entry field of the number of subranges or peaks for the determination of the peak list. The range of values is 1 to 500.

IEC/IEEE-bus command

```
:CALCulate<1|2>:PEAKsearch:SUBRanges 1...500
```

PEAKS SUBRANGES

The *PEAKS SUBRANGES* softkey defines the search method with which maxima are searched for within a scan.

PEAKS — Determination of a specific number of peak values relative to the limit lines with the level values being independent of their frequency spectral distribution.

SUBRANGES — Generating subrange maxima, ie the interference spectrum is further analyzed at frequencies with the highest interference level of a frequency subrange.

IEC/IEEE-bus command

```
:CALCulate<1|2>:PEAKsearch:METHod SUBRange | PEAK
```

MARGIN

The *MARGIN* softkey activates the entry field of the margin, ie of an additional acceptance threshold for the determination of the peak list. The limit line currently used is shifted by this amount for defining the maxima. The range of values is -200 dB to 200 dB.

IEC/IEEE-bus command

```
:CALCulate<1|2>:PEAKsearch:MARGin -200dB to 200dB
```

FINAL MEAS TIME

The *FINAL MEAS TIME* softkey activates the entry field of the time of final measurement.

IEC/IEEE-bus command

```
:[SENSe:]SWEep:FMEasurement <num_value>
```

AUTOMATIC FINAL

The *AUTOMATIC FINAL* softkey selects the automatic routine for the final measurement. This routine is run according to the available frequency list without user interaction.

IEC/IEEE-bus command --

INTER ACTIVE

The *INTERACTIVE* softkey selects the following sequence for the final measurement:

- A frequency from the frequency list is set on the receiver together with the associated settings from the corresponding partial scan.
- The marker is set on this frequency in the scan diagram.
- The final measurement sequence switches to the *Interrupted* status.
- The signal can be exactly analyzed by modifying the receiver settings.
- *CONTINUE AT HOLD* starts the actual final measurement, the receiver settings being restored except the frequency.
- The current frequency replaces the original one in the frequency list (drifting interference sources)
- Next frequency of frequency list.....

Note: *With the AUTOMATIC FINAL softkey in the CONTINUE FINAL MEAS submenu a switchover can be made to the automatic mode before the measurement is started anew.*

IEC/IEEE-bus command --

RUN FINAL MEAS ▶ HOLD FINAL MEAS

The *RUN FINAL MEAS* softkey starts the final measurement sequence as described above. The *HOLD FINAL MEAS* submenu is called.

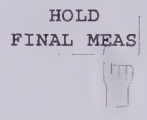
The detectors used for the final measurement replace those used in the list or for the prescan.
The out-of-limit condition is shown by a plus sign preceding the values in the DELTA LIMIT column (see table below).

HOLD FINAL MEAS

STOP FINAL MEAS

IEC/IEEE-bus command --

Note: *The final measurement function is only available in the manual mode. For operation under program control it is preferable to read the prescan results and the data-reduced peak list, if any, from the ESI with the controller and carry out the individual measurements with the controller. This considerably makes the control of the interactive mode easier.*



The *HOLD FINAL MEAS* softkey interrupts the automatic run of the final measurement.

The *CONTINUE FINAL MEAS* submenu appears.

With the final measurement halted all receiver settings can be modified for example for examining the signal in detail.
The mode of the measurement (automatic or interactive) can again be selected.

The final measurement can be started with the *MEASURE* softkey.

IEC/IEEE-bus command - -

AUTOMATIC FINAL

The *AUTOMATIC FINAL* softkey selects the automatic mode for the final measurement (see above).

IEC/IEEE-bus command - -

INTER ACTIVE

The *INTERACTIVE* softkey selects the interactive mode for the final measurement as described above.

IEC/IEEE-bus command - -

SKIP FREQUENCY

The *SKIP FREQUENCY* softkey skips the next entry in the FREQUENCY column.

IEC/IEEE-bus command - -

MEASURE

The *MEASURE* softkey continues with the final measurement. The final measurement starts at the next frequency entry on the peak list or at a marked frequency if one or several lines have been skipped with the SKIP FREQUENCY softkey.

IEC/IEEE-bus command - -

STOP FINAL MEAS

The *STOP FINAL MEAS* softkey halts the final measurement. The final measurement starts from the beginning on a new start. The previously collected data are lost.

IEC/IEEE-bus command - -

The peak list available after the final measurement:
The detectors used for the final measurement replace those used in the list or for the prescan.
The out-of-limit condition is shown by a plus sign preceding the values in the DELTA LIMIT column.

EDIT PEAK LIST (Final Measurement Results)

Trace1: 014QP Trace2: 014AV
Trace3: --- Trace4: ---

	TRACE	FREQUENCY	LEVEL dBpT	DELTA LIMIT dB
2	Average	80.0000 MHz	29.99	-9.26
2	Average	89.4800 MHz	35.64	-4.09
1	Quasi Peak	98.5200 MHz	49.94	-0.22
2	Average	98.5200 MHz	48.32	8.15
1	Quasi Peak	100.7200 MHz	55.33	5.07
2	Average	102.3200 MHz	50.86	10.53
1	Quasi Peak	113.2400 MHz	42.50	-8.26
2	Average	116.9200 MHz	44.44	3.53
1	Quasi Peak	125.8800 MHz	54.91	3.68
2	Average	125.8800 MHz	53.86	12.64
1	Quasi Peak	138.4800 MHz	41.83	-9.81
2	Average	138.4800 MHz	39.38	-2.25
2	Average	144.0400 MHz	40.77	-1.04
2	Average	167.0400 MHz	44.82	2.37
2	Average	176.2400 MHz	46.56	3.87
1	Quasi Peak	200.4800 MHz	50.93	-2.31
2	Average	200.4800 MHz	48.27	5.02
1	Quasi Peak	210.2800 MHz	58.71	5.25
2	Average	226.5600 MHz	59.07	15.29
2	Average	230.0000 MHz	46.90	3.05

Selection of Detectors for Final Measurement

The selection of detectors for the final measurement is made in the *TRACE* menu (see section "Selection and setting of traces ").

The detectors to be used for the final measurement can be set here for each trace, ie any combination of prescan and final measurement is possible. The required flexibility is thus obtained for the diverse test specifications which are covered by means of the ESI.

Traces 3 and 4 can be used for displaying the final measurement values. For this purpose, the *FINAL MEAS* softkey should be activated in the associated menu. Trace 3 represents the allocated final measurement values referring to trace 1 with the symbol "x" and trace 4 the final measurement values for trace 2 with "+".
The results of prescan and final measurement in a diagram:

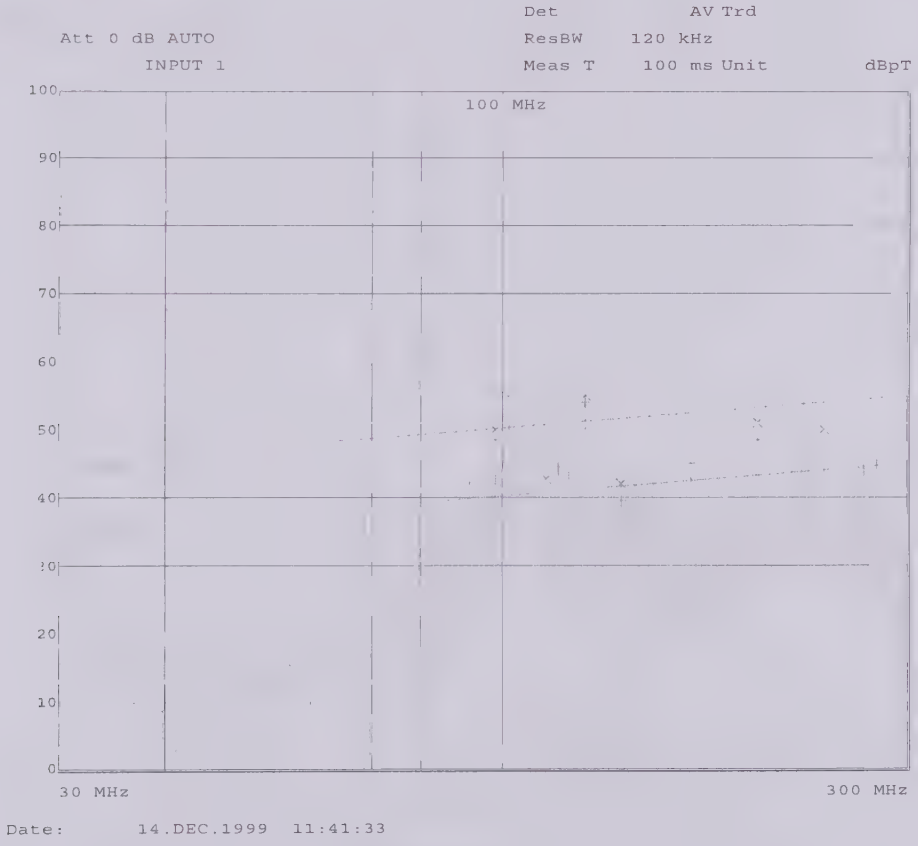
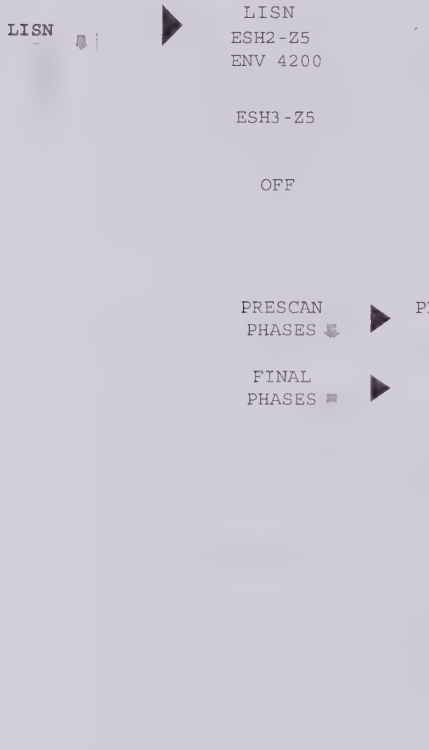


Fig. 4-8 Results of prescan and final measurement

Automatic Control of Line Impedance Stabilization Networks

The selected phases are controlled during the prescan and the final measurement via the USERPORT with the LISN switched on. In contrast, the LISN menu in the SETUP menu is used for the direct control of the LISN and is not included in the automatic sequences.
Only one phase and one PE setting (1 out of n) can be selected for the prescan. Any number of settings can be selected for the final measurement (m out of n).
All selected phase/PE combinations are measured during the final measurement and the maximum value is determined.

CONFIGURATION MODE - EMI RECEIVER menu (right side menu)



The *LISN* softkey opens the submenu for automatic control of V-networks (LISNs)

ESH2-Z5
ENV 4200

Softkeys *ESH2-Z5/ENV 4200, ESH3-Z5* and *OFF* allow to select the V-network to be controlled via the user port.

ESH2-Z5/ENV 4200 four-line V-network is controlled,

ESH3-Z5 two-line V-network is controlled,

ESH3-Z5

OFF remote control is deactivated.

IEC/IEEE-bus command

```
:INPut:LISN[:TYPE]  TWOPhase| FOURphase| OFF
```

OFF

PRESCAN PHASES

FINAL PHASES

The *PRESCAN PHASES* and *FINAL PHASES* softkeys open the submenu for the selection of phase and protective earth setting.

PRESCAN PHASES: Softkeys *ESH2-Z5/ENV 4200*, *ESH3-Z5* and *OFF* or *PHASE N*, *PHASE L1*, *PHASE L2* and *PHASE L3* as well as *PE GROUNDED* and *PE FLOATING* are toggle keys. Only one of them can be activated at a time.

FINAL PHASES: All combinations of phases and PE setting are possible.

PHASE N

PHASE L1

PHASE L2

PHASE L3

Softkeys *PHASE N, PHASE L1, PHASE L2* and *PHASE L3* select the phase of the V-network on which the RFI voltage is to be measured.*1*

PHASE N RFI on phase N is measured,

PHASE L1 RFI on phase L1 is measured,

PHASE L2 RFI on phase L2 is measured (only for ESH2-Z5/ENV 4200),

PHASE L3 RFI on phase L3 is measured (only for ESH2-Z5/ENV 4200).

IEC/IEEE-bus command
`:INPut:LISN:PHASe L1| L2| L3| N`

PE GROUNDED

PE FLOATING

Softkeys *PE GROUNDED* and *PE FLOATING* switch the protective earth conductor chokes on or off.

PE GROUNDED protective earth conductor choke switched off,

PE FLOATING protective earth conductor choke switched on.

IEC/IEEE-bus command
`:INPut:LISN:PEARth GROunded|FLOating`

Frequency and Span Selection – *FREQUENCY Key Group*

The *FREQUENCY* key group is used to specify the receiver frequency and the frequency axis of the active measurement . The frequency axis is defined by the start and stop frequency.
After pressing one of the keys *FREQ*, *START* or *STOP*, the value of the corresponding parameter can be defined in the appropriate dialog window.

Start Frequency – *START Key*

FREQUENCY – START menu:

FREQUENCY
CENTER/ FREQ | SPAN/ ZOOM
START | STOP

The *START* key opens a window where the start frequency of the scan diagram can be entered.

The start frequency can be selected in the ESI frequency range irrespective of scan range limits.

IEC/IEEE bus command : `[SENSe:]FREQuency:STARt <num_value>`

Stop Frequency – *STOP Key*

FREQUENCY – STOP menu:

FREQUENCY
CENTER/ FREQ | SPAN/ ZOOM
START | STOP

The *STOP* key opens a window where the stop frequency of the scan diagram can be entered.

The stop frequency can be selected in the ESI frequency range irrespective of scan range limits.

The permissible value range for the stop frequency is:

$f_{stop} > f_{start}$

IEC/IEEE bus command : `[SENSe:]FREQuency:STOP <num_value>`

Receiver Frequency – *FREQ Key*

FREQUENCY – FREQ menu:

FREQUENCY
CENTER/ FREQ | SPAN/ ZOOM
START | STOP

The *FREQ* key opens a window where the receiver frequency can be entered.
A precondition is that the frequency and level readout is active.

The permissible value range depends on the selected input:

Input 1: $20\ Hz \leq f_{in} \leq f_{max}$
Input 2: $20\ Hz \leq f_{in} \leq 1\ GHz$

If the tuning frequency is lower than twice the IF bandwidth, the IF bandwidth is automatically reduced so that this condition is met again.
If the frequency is increased again, the original IF bandwidth is restored. The memory is cleared when the IF bandwidth is manually changed.

The resolution of the receive frequency is always 0.1 Hz.

IEC/IEEE bus command : `[SENSe:]FREQuency:STOP <num_value>`

Receiver Frequency Step Size

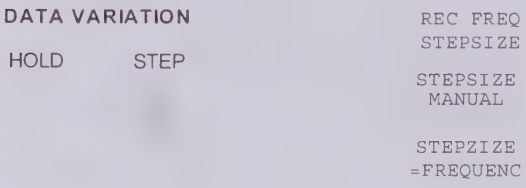
The *STEP* key in the *DATA VARIATION* key group opens a menu for setting the step size of the receiver frequency. The step size can be coupled to the receiver frequency or be manually set to a fixed value.

In order to change the step size, the entry window for the receiver frequency must already be active. After pressing the *STEP* key, the *REC FREQ STEP* menu appears.

The softkeys are mutually exclusive selection switches. Only one switch can be active at a time.

Control is returned to the *FREQUENCY FREQ* menu via the menu key .

DATA VARIATION - STEP menu



STEPSIZE MANUAL

The *STEPSIZE MANUAL* softkey activates the entry window for the input of a fixed step size.

IEC/IEEE bus command `:[SENSe:]FREQuency:CENTer:STEP <num_value>`

STEPSIZE = FREQUENC

The *STEPSIZE = FREQUENC* softkey sets the step size coupling to *MANUAL* and the step size to a value equal to the receiver frequency.
This function is especially useful during measurements of the signal harmonic content, because, when entering the receiver frequency, the receiver frequency of another harmonic is selected with each stroke of the *STEP* key.

IEC/IEEE bus command --

Level Display and RF Input Configuration – *LEVEL Key Group*

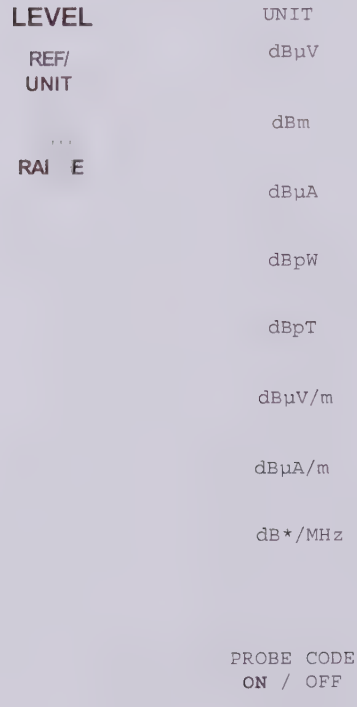
The *UNIT* and *RANGE* keys are used to set the display units and the display range of the scan diagram. The *INPUT* key sets the characteristics of the RF input (input, input attenuation, and preamplification).

Display Units - *UNIT* Key

In general, a receiver measures the signal voltage at the RF input. The level display is calibrated in rms values of an unmodulated sinewave signal. In the initial state, the level is displayed in dBµV. Via the known input resistance of 50 Ω a conversion can be made to other units. The units dBm, dBµA, dBpW, and dBpT are directly convertible and can be selected in the *UNIT* menu.
If the antenna coded connector on the front panel is used, the coded unit there determines the possible display units. Connecting to the coded connector deactivates the settings of the *UNIT* menu.
By certain codings it is nevertheless possible to select a conversion of the unit in the menu. The dependencies between the unit of the antenna coded connector and the unit which is to be selected for the display are given in the softkey description.

The default coding defined by the connector can be switched off using the *PROBE CODE ON/OFF* softkey. In this case, the unit can be set with the corresponding unit softkeys (dBm, dBµV, ...) even if a coded connector is plugged in. The coded entries in the connector are then ignored.

LEVEL UNIT submenu:



The *UNIT* key opens a submenu in which the desired units for the level axis can be selected and the coding of the antenna coded connector can be switched on and off.

The unit softkeys are mutually exclusive selection switches. Only one of these switches may be active at any one time.

dBµV

dBm

dBµA

dBpW

dBpT

dBµV/m

dBµA/m

dB*/MHz

The *dBµV, dBm, dBµA, dBpW, dBpT, dBµV/m, dBµA/m, dB*/MHz* softkeys set the display units to the corresponding logarithmic units.

The dB*µV* unit is the default unit in receiver mode.

IEC/IEEE bus command `:CALCulate<1|2>:UNIT:POWer DBMV | DBM | DBUA | DBPW | DBPT | DBUV_M | DBUA_M | DBUV_MHZ | DBUA_MHZ | DBMV_MHZ`

PROBE CODE ON / OFF

The *PROBE CODE ON/OFF* softkey enables or disables the units defined by the coded connector.

IEC/IEEE bus command `:UNIT:PROBe ON | OFF`

Level Range – *RANGE* Key

LEVEL RANGE menu:

LEVEL

REF/ UNIT

RANGE

LEVEL RANGE

LOG 120 dB

LOG 100 dB

LOG 50 dB

LOG 20 dB

LOG 10 dB

LOG MANUAL

GRID MAX LEVEL

GRID MIN LEVEL

The *RANGE* key calls a menu in which the range for the scan diagram can be selected.

The default setting is 100 dB.

The most often used settings (120 dB, 100 dB, 50 dB, 20 dB and 10 dB) are each directly selectable by a softkey.
All other ranges are chosen with the *LOG MANUAL* softkey.

When the display range is changed, *GRID MAX LEVEL* and *GRID MIN LEVEL* are newly set. *GRID MIN LEVEL* is not changed, however.

Editing of *GRID MAX LEVEL* and *GRID MIN LEVEL* sets *LOG MANUAL*.

LOG MANUAL

The *LOG MANUAL* softkey activates the entry of the level display range. The display rangesgo from 10 to 200 dB in 10-dB steps. Invalid entries are rounded off to the nearest valid value.

IEC/IEEE bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing LOG
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y:SCALe 110DB
```

GRID MAX LEVEL

The *GRID MAX LEVEL* softkey activates the entry of the maximum level of the display range. Values from -83 dBµV to +307 dBµV are allowed.

IEC/IEEE bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing LOG
:DISP[:WINDow<1|2>]:TRACe<1. 4>:Y[:SCALe]:TOP <num_value>
```

GRID MIN LEVEL

The *GRID MIN LEVEL* softkey activates the entry of the minimum level of the display range. Allowed values are:

GRID MAX LEVEL - 200 ≤ GRID MIN LEVEL ≤ GRID MAX LEVEL - 10

IEC/IEEE bus commands

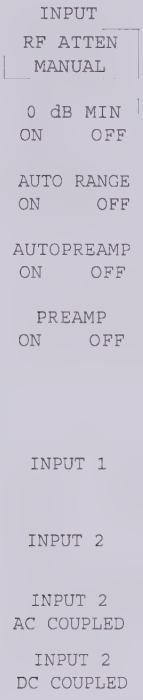
```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing LOG
:DISP[:WIND<1|2>]:TRACe<1. 4>:Y[:SCAL]:BOTTom <num_value>
```

RF Input Configuration – *INPUT* Key

In addition to manual entry of the input attenuation, the ESI provides an option which allows the RF attenuation, dependent on the selected reference level, to be automatically set.

INPUT menu:

INPUT



The *INPUT* key opens the menu for configuring the RF input. It contains the input attenuator for matching the RF input to the input signal, the auto ranging of the preamplifier, and the selection of the input.

RF ATTEN MANUAL

The *RF ATTEN MANUAL* softkey activates the entry of an attenuation factor irrespective of the reference level.

The following attenuation factor can be set irrespective of the active input:

- INPUT 1: 0 to 70 dB in 10 dB steps,
- INPUT 2: 0 to 70 dB in 5 dB steps.

Other entries are rounded down to the nearest integer.

IEC/IEEE bus command `:INPut<1|2>:ATTenuation 40DB`

0 DB MIN
ON OFF

The *0 DB MIN* softkey determines whether the 0 dB setting of the attenuator may be used in the manual or automatic setting of the attenuator.

0 DB MIN OFF is the default value, ie an RF attenuation of at least 10 dB is always set on ESI to protect the input mixer.

An attenuation factor of 0 dB cannot be set manually either. This prevents 0 dB being switched on inadvertently particularly when DUTs with high RFI voltage are measured.

Caution:

If 0 dB RF attenuation is used with autoranging, care must be taken that the permissible signal level at the RF input is not exceeded. Exceeding this level would damage the input mixer. The 0 dB attenuation should under no circumstances be used when RFI voltage measurements are performed with the aid of artificial networks as in this case very high pulses occur during phase switching.

IEC/IEEE bus command
`:INPut<1|2>:ATTenuation:PROTection ON|OFF`

AUTO RANGE
ON OFF

The *AUTO RANGE ON/OFF* softkey switches auto ranging on or off.

When the autorange function is active, ESI automatically sets the selected attenuation so that a good S/N ratio is obtained without the receiver stages being overdriven.

IEC/IEEE bus command `:INPut<1|2>:ATTenuation:AUTO ON | OFF`

AUTOPREAMP
ON OFF

The *AUTOPREAMP ON/OFF* softkey switches the autopreamp function on or off.

When the autopreamp function is active, the preamplifier is considered in the autorange procedure. The preamplifier is only switched on when the RF attenuation is reduced to the lowest settable value.
This function can only be controlled when the preamplifier is switched on.

IEC/IEEE bus command `:INPut<1|2>:GAIN:AUTO ON | OFF`

PREAMP
ON OFF

The *PREAMP ON/OFF* softkey switches the preamplifier on and off.

IEC/IEEE bus command `:INPut<1|2>:GAIN:STATe ON | OFF`

INPUT 1

The *INPUT 1* softkey selects input 1 (default setting).

INPUT 2

The *INPUT 2* softkey selects input 2.
The *INPUT 2* softkey switches on the pulse-resistant input 2. With the input 2 used, the frequency range is limited to 2 GHz. Higher frequencies cannot be set.

IEC/IEEE bus command `:INPut:TYPE INPUT1 | INPUT2`

INPUT 2
AC COUPLED

The softkeys *INPUT 2 DC COUPLED* and *INPUT 2 AC COUPLED* chose DC or AC coupling for the RF input 2.

Default setting is AC coupling.

The bottom frequency limit is 1 kHz.

INPUT 2
DC COUPLED

To indicate that input 2 is used (with AC or DC coupling), the enhancement labels **I2A** or **I2D** are shown on the display.

When using the input 1, the two softkeys are then not offered for selection (enhancement label IN1).

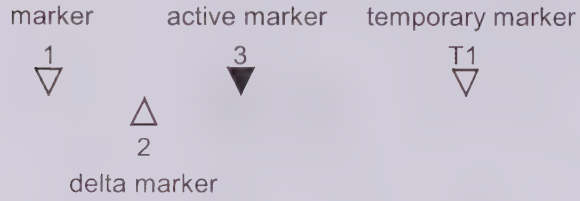
IEC/IEEE bus command `:INPut:COUPling AC | DC`

Marker Functions – *MARKER Key Group*

The markers are used for marking points on measurement curves, reading out measurement values and for quickly selecting a display screen segment. Preselected measurement routines can be called by pressing a key in the marker menu. The ESI provides four markers and four delta markers. The currently activated marker can be shifted with the cursor keys, the roll-key or the softkeys.

The marker which can be moved by the user is defined as the **active marker**.

Examples:



The measurement values of the active marker (also called **marker values**) are displayed in the marker field. In the **marker info list**, the measurement values from all enabled markers are sorted in ascending order. The marker info list can be switched off with the *MARKER INFO* softkey so that only the values for the active marker are shown.

Main Markers– *NORMAL Key*

MARKER

NORMAL SEARCH

DE A MKR→

MARKER NORMAL

MARKER 1

MARKER 2

MARKER 3

MARKER 4

MARKER ZOOM

PREV ZOOM RANGE

ZOOM OFF

MARKER INFO

ALL MARKER OFF

The *NORMAL* key calls a menu which contains all marker standard functions. The current state of the markers is indicated by a colored illumination of the softkeys. If no marker is enabled prior to pressing the *NORMAL* key, *MARKER 1* will be enabled as the reference marker and a peak search on the measurement curve is carried out (assumption: at least one measurement curve is active). Otherwise, the peak search is omitted and the entry window for the reference marker is activated.

The marker field at the upper left of the display screen shows the marker location (here, frequency), the level and the currently selected measurement curve.

```
MARKER 1  [T1]
  -27.5 dBm
 123.4567 MHz
```

Measured scan data can be subsequently represented in an expanded form using the zoom function. If the measured values obtained are more than the available pixels, several measured values are combined to one pixel. This compression is performed again for each zoom operation.

At the same time, the scan start and stop frequencies are set to the new diagram limits. A newly started scan then sweeps only the currently represented frequency range

MARKER
NORMAL

MARKER 1

MARKER 2

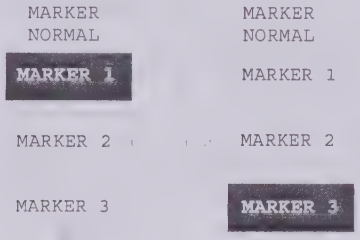
MARKER 3

MARKER 4

The *MARKER 1* to *MARKER 4* softkeys switch the corresponding marker on/off or activate it as the reference marker. If the marker is activated as a reference marker, an entry field for manually setting the position of the reference marker is opened simultaneously. If the marker is disabled, the softkey is not illuminated. Enabled markers and the reference marker are indicated by illuminating the corresponding softkeys in different colors.(In the instrument default state, the active reference marker is displayed in red and enabled markers are displayed in green.)

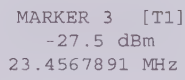
Operating example:

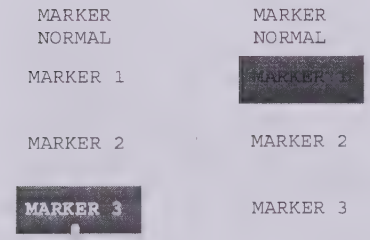
MARKER 1 is shown as the reference marker by the colored background illumination. *MARKER 2* through *MARKER 4* are turned off.



Pressing the *MARKER 3* softkey switches *MARKER 3* on and it becomes the reference maker. The previous reference marker remains enabled and the softkey remains illuminated. However, the entry mode for this marker is not now active. Instead, the entry window for *MARKER 3* is opened and the position of *MARKER 3* can be shifted.

The information in the marker field also changes to describe the new reference marker.





Pressing the current reference marker (*MARKER 3)* softkey again switches *MARKER 3* off. If at least one marker is enabled, the marker with the smallest number will be selected as the new reference marker (in the example, *MARKER 1*). Switching off the last active marker also deletes are delta markers.

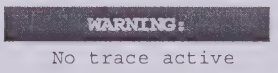
IEC/IEEE bus commands

```
:CALCulate<1|2>:MARKer<1..4>[:STATe]  ON | OFF;
:CALCulate<1|2>:MARKer<1..4>:X  10.7MHz;
:CALCulate<1|2>:MARKer<1..4>:Y?
```

When several measurement curves (traces) are being displayed, the marker is set to the maximum value (peak) of the active curve which has the lowest number (1 to 4). In case a marker is already located there, it will be set to the frequency of the next highest level (next peak).

If a measurement curve is turned off, the corresponding markers and marker functions are also erased. If the curve is switched on again (*VIEW*, *CLR/WRITE*;..), these markers along with coupled functions will be restored to their original positions.
A prerequisite for the restoration of the marker positions is that individual markers have not been used on another measurement curve or that the scan data (start/stop frequency) have not been changed.

If a marker (or, delta marker) necessary for a marker function is not available, it will be automatically checked whether or not the enabling of the corresponding marker is possible (see above). If this is not the case, a warning is issued.



The activation of the desired marker function is then not possible.

On the other hand, if the marker can be enabled, a peak search is automatically performed. Thereafter, the desired marker function can be executed.

MARKER NORMAL menu:

MARKER ZOOM

The *MARKER ZOOM* softkey zooms 10% of the diagram around the current marker. It opens at the same time a data entry field which allows to enter any frequency range which is then displayed
Pressing the softkey again expands the diagram such that only 3 measured values are represented.

IEC/IEEE bus command

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:ZOOM <num_value>
```

PREV ZOOM RANGE

The *PREVIOUS ZOOM* softkey sets again the previous frequency range

IEC/IEEE bus command --

ZOOM OFF

The *ZOOM OFF* softkey switches off the zoomed representation.

IEC/IEEE bus command
`:DISPlay[:WINDow<1|2>]:TRACe<1...4>:X[:SCALe]:ZOOM OFF`

ALL MARKER OFF

The *ALL MARKER OFF* softkey switches off all markers (reference and delta markers). Similarly, it switches off all functions and displays correlated with the markers/delta markers.

IEC/IEEE bus command `:CALCulate<1|2>:MARKer<1...4>:AOFF`

MARKER INFO

The *MARKER INFO* softkey opens the display of several markers within the grid. In the upper right corner of the grid, a maximum of 4 markers/delta markers with the marker symbols Δ/∇, marker number (1 to 4), position and measurement value are listed. For the output of the marker position, the number or displayed characters will be limited as required.

If the number of lines available is not enough for all the enabled markers and delta markers, first the markers and then the delta markers are entered into the info list

IEC/IEEE bus command `:DISPlay:WINDow<1|2>:MINFo ON | OFF`

Marker Step Size

DATA VARIATION – STEP menu:

The *STEP* key in the *DATA VARIATION* key group opens a menu to match the marker step size to each individual application. In order to change the step size, the marker entry mode must already be active.

Control is returned to the *MARKER NORMAL* menu via the menu key .

STEPSIZE AUTO

The *STEPSIZE AUTO* softkey sets the marker step size to *AUTO*. In this case, the step size is exactly 10% of the grid. A one-raster movement of the roll-key corresponds to one pixel.

STEPSIZE AUTO is the default setting.

IEC/IEEE bus command

```
:CALCulate<1|2>:MARKer<1..4>:STEP:AUTO  ON|OFF
```

STEPSIZE MANUAL

The *STEPSIZE MANUAL* softkey activates the entry window for defining a fixed value for the marker step size.

Pressing the step key shifts the marker position by the selected step size. The resolution of the roll-key is always one pixel per raster.

IEC/IEEE bus command

```
:CALCulate<1|2>:MARKer<1..4>:STEP 10KHZ
```

MKR TO STEPSIZE

The *MKR TO STEPSIZE* softkey sets the marker step size to the current marker frequency.

This function is well suited to harmonic measurements. The marker is set to the largest signal using the peak search function. After activation of the *MKR TO STEPSIZE* function, the marker is set to the corresponding harmonic of the signal each time the cursor key or is pressed when entering the marker position.

IEC/IEEE bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:MSTep
```

DELTA TO STEPSIZE

The *DELTA TO STEPSIZE* softkey sets the marker step size to the difference between the reference marker and the last active delta marker.

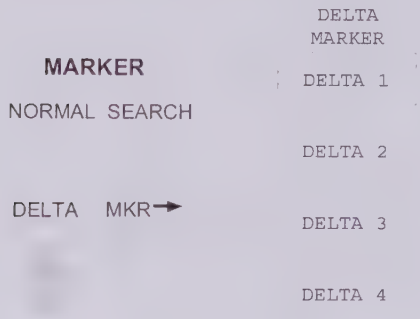
The softkey is only available when at least one delta marker is enabled.

IEC/IEEE bus command --

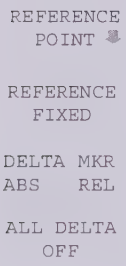
Delta Markers – *DELTA Key*

The delta markers are used to measure a level or frequency referred to a reference marker. They are always referenced to the marker whose position was last changed. A delta marker is displayed as an empty △ symbol. The reference marker is displayed as a filled ▼ symbol.

MARKER DELTA menu:



The *DELTA* key switches a delta marker on and calls the menu for its control. If no marker is enabled, *MARKER 1* is automatically activated when the delta marker is switched on. The delta marker activated to entry mode is shown on the display screen as a filled ▲ symbol.



DELTA 1

DELTA 2

DELTA 3

DELTA 4

The *DELTA 1 to 4* softkeys are used to enable delta markers 1 to 4. The control of the delta markers corresponds to that of the markers. After a delta marker has been enabled, all entries are now applicable to this marker. The main marker must be activated anew if its position is to be changed.

The delta marker field on the display screen contains the delta marker number, the difference frequency from the delta marker to reference marker and the level difference between the active delta markers and reference markers.

The indicated differences are, in general, referred to the reference marker. If the *REFERENCE FIXED* function are enabled, the reference values under *REFERENCE POINT* are applicable.

IEC/IEEE bus commands

```
:CALCulate<1|2>:DELTamarker<1..4>  ON|OFF
:CALCulate<1|2>:DELTamarker<1..4>:X 10.7MHZ
:CALCulate<1|2>:DELTamarker<1..4>:X:REL?
:CALCulate<1|2>:DELTamarker<1..4>:Y
```

DELTA MKR
ABS REL

The *DELTA ABS REL* softkey switches between relative and absolute entry modes for the delta-marker frequency.

REL The delta marker frequency is entered relative to the reference marker. In this case, the entry mode for the delta-marker frequencies is also relative.

ABS The entry of the delta-marker frequency is in terms of absolute frequency.

The default setting is *REL*.

IEC/IEEE bus command
`:CALCulate<1|2>:DELTamarker<1..4>:MODE ABS | REL`

ALL DELTA
OFF

The *ALL DELTA OFF* softkey switches off all active delta markers and any associated functions (e.g. *REFERENCE FIXED*).

IEC/IEEE bus command
`:CALCulate<1|2>:DELTamarker<1...4>:AOFF`

REFERENCE
FIXED

The *REFERENCE FIXED* softkey enables/disables relative measurements with respect to a fixed, measurement-curve-independent reference value (*REFERENCE POINT*).

The information in the delta-marker field on the display screen is referenced to this fixed reference point. For the generation of the marker lists using *MARKER INFO* list, the delta markers are also output relative to a fixed reference. In the lists, the *REFERENCE POINT* is tagged by the number of the reference marker (only one enabled)

When *REFERENCE FIXED* is enabled, the current settings of the reference marker become the reference points. If no marker is active, *MARKER 1* (with peak search) is activated. After transferring the reference values, all markers are deleted, and the active delta marker is set to the position of the reference point. Additional delta markers can be switched on.

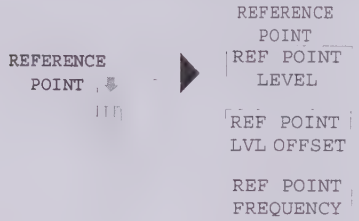
The reference point can be subsequently changed

1. by shifting it in the *REFERENCE POINT* sub-menu.

2. by starting a search:
   In the *MARKER NORMAL* menu the *REF POINT* is handled as a reference marker (even though it is not bound to the measurement curve). This means, that it will be shown as enabled and can also be changed in position. The co-ordinates of the *REF POINT* are overwritten by the marker values (they lie, by definition, on the measurement curve). Thus, it is possible, even for an enabled *REFERENCE FIXED*, to define a new reference point with search functions.

IEC/IEEE bus command
`:CALCulate<1|2>:DELTamarker<1..4>:FUNCtion:FIXed ON|OFF`

MARKER DELTA- REFERENCE POINT submenu:



The *REFERENCE POINT* softkey opens a sub-menu in which the reference value of the *REFERENCE FIXED* function can be modified.

The position of the reference point is indicated by two additional display lines (horizontal and vertical). In addition, an offset level may be defined which is added to each difference during output.

The softkey is only available when the *REFERENCE FIXED* function is switched on.

REF POINT LEVEL

The *REF POINT LEVEL* softkey activates an entry box for setting the reference level relevant to the *REFERENCE FIXED* function.

IEC/IEEE bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIXed:RPOint:Y -10DBM
```

REF POINT LVL OFFSET

The *REF POINT LVL OFFSET* softkey activates the entry box for the entry of an additional offset level during output when the *REFERENCE FIXED* function are enabled.

The offset level is set to 0 dB when the *REFERENCE FIXED* function are switched on

IEC/IEEE bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIX:RPO:Y:OFFSet 10DB
```

REF POINT FREQUENCY

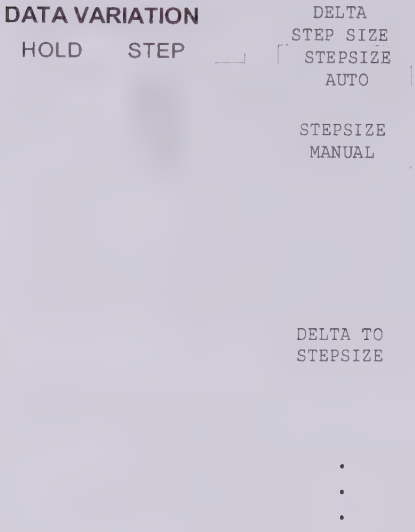
The *REF POINT FREQUENCY* softkey activates the entry box for the input of a reference frequency for the *REFERENCE FIXED* function.

IEC/IEEE bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIXed:RPOint:X 10.7MHZ
```

Delta-Marker Step Size - *STEP Key*

STEP-DELTA STEP menu:



The *STEP* key in the *DATA VARIATION* key group opens a menu to match the step size of the individual delta markers to the specific application. In order to change the step size, the entry mode for a delta marker must already be active.

Control is returned to the DELTA MARKER menu via the menu key .

STEPSIZE AUTO

The *STEPSIZE AUTO* softkey sets the delta marker step size to *AUTO*. In this case, the step size of the delta marker is exactly 10% of the grid. The roll-key corresponds to 1/500, i.e., for each rotational pulse, the delta marker is shifted one pixel position.

IEC/IEEE bus command
`:CALCulate<1|2>:DELTamarker<1..4>:STEP:AUTO ON | OFF`

STEPSIZE MANUAI

The *STEPSIZE MANUAL* softkey permits the entry of a fixed value for the delta marker step size.

Pressing the step-key shifts the marker position by the selected step size. The roll-key resolution, however, always remains constant at 1 pixel.

IEC/IEEE bus command --

DELTA TO STEPSIZE

The *DELTATO STEPSIZE* softkey sets the delta marker step size to a quantity equal to the difference between the delta and reference markers.

The softkey is only presented when at least one delta marker is switched on.

IEC/IEEE bus command `:CALCulate<1|2>:DELT<1..4>:STEP 10HZ`

Search Functions – SEARCH Key

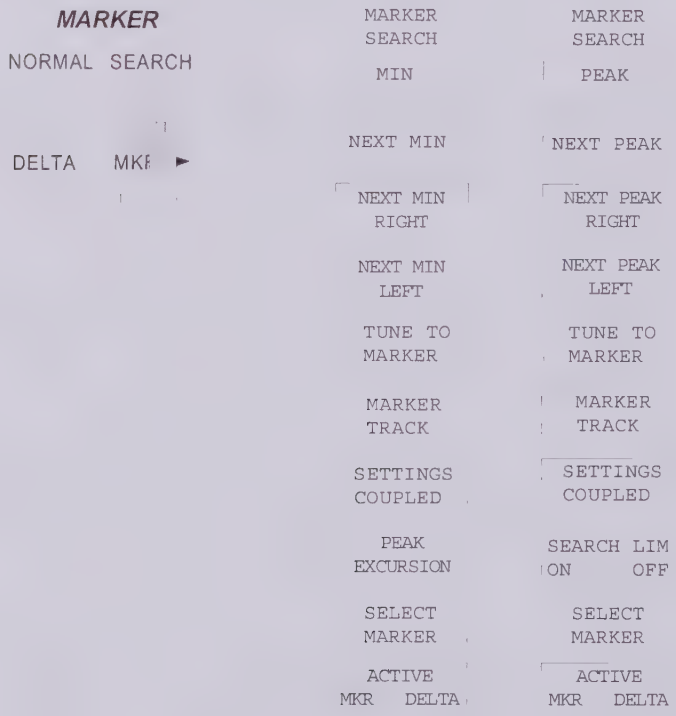
The ESI offers numerous functions useful for peak/min. peak searching. The search functions can be used for marker as well as delta marker functions.

The setups applicable to the available search functions are performed in the *MARKER-SEARCH* menu.

The search functions are always related to the currently active marker. If the *SEARCH* key is pressed while the marker entry mode is active, then all search functions are related to the current reference marker. If the entry mode of a delta marker is active, then the functions will be applied to the corresponding delta marker. For the case where no marker is active, *MARKER* 1 will be automatically enabled (with peak search). The *ACTIVE MKR / DELTA* softkey allows toggling between the active marker and the active delta marker.

If the threshold line is turned on, the peak/min. search functions will only evaluate signals which have a level above/below the selected threshold. In addition, the search range can also be limited (*SEARCH LIM ON/OFF* softkey) by the frequency lines (*FREQUENCY LINE 1/2*).

MARKER SEARCH menu:



ACTIVE MKR / DELTA

The *ACTIVE MKR / DELTA* softkey toggles between the active marker and the active delta marker.

If *DELTA* is illuminated, the following search functions are performed with the active delta marker.

Note: *Switching between marker and delta marker entry modes may also be performed using the NORMAL and DELTA keys.*

IEC/IEEE bus command --

SELECT MARKER

The *SELECT MARKER* softkey activates the selection of the marker/delta markers. The selection box lists the currently enabled markers/delta markers.

IEC/IEEE bus command --

PEAK

The *PEAK* softkey sets the active marker/delta marker to the peak of the corresponding trace.

IEC/IEEE bus commands
```
:CALCulate<1|2>:MARK<1..4>:MAXimum
:CALCulate<1|2>:DELT<1..4>:MAXimum
```

NEXT PEAK

The *NEXT PEAK* softkey sets the active marker/delta marker to the next lower peak on the corresponding trace.

IEC/IEEE bus command
```
:CALCulate<1|2>:MARKer<1..4>:MAX:NEXT
:CALCulate<1|2>:DELT<1..4>:MAX:NEXT
```

NEXT PEAK RIGHT

The *NEXT PEAK RIGHT* softkey sets the active marker to the next peak to the right of the current marker.

IEC/IEEE bus command
```
:CALCulate<1|2>:MARK<1..4>:MAX:RIGHt
:CALCulate<1|2>:DELT<1..4>:MAX:RIGHt
```

NEXT PEAK LEFT

The *NEXT PEAK LEFT* softkey sets the active marker to the next peak to the left of the current marker.

IEC/IEEE bus command
```
:CALCulate<1|2>:MARK<1..4>:MAX:LEFT
:CALCulate<1|2>:DELT<1..4>:MAX:LEFT
```

TUNE TO MARKER

The *TUNE TO MARKER* softkey sets the receiver frequency to the marker frequency.

IEC/IEEE bus command
```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:CENTer
```

MARKER TRACK

The *MARKER TRACK* softkey couples the current receive frequency to the marker frequency.

IEC/IEEE bus command
`:CALCulate<1|2>:MARKer<1..4>:COUPled[:STATe] ON|OFF`

SETTINGS COUPLED

The *SETTINGS COUPLED* softkey couples the receiver frequency settings from the corresponding subscans to the marker frequency for functions *TUNE TO MARKER* and *MARKER TRACK*.

IEC/IEEE bus command
`:CALCulate<1|2>:MARKer<1..4>:SCOupled[:STATe] ON|OFF`

MIN

The *MIN* softkey sets the active marker to the lowest peak on the corresponding trace.

IEC/IEEE bus command
`:CALCulate<1|2>:MARKer<1..4>:MIN`
`:CALCulate<1|2>:DELTamarker<1..4>:MIN`

NEXT MIN

The *NEXT MIN* softkey sets the active marker to the next higher of the low peaks on the corresponding trace.

IEC/IEEE bus command
`:CALCulate<1|2>:MARK<1..4>:MIN:NEXT`
`:CALCulate<1|2>:DELT<1..4>:MIN:NEXT`

NEXT MIN RIGHT

The *NEXT MIN RIGHT* softkey sets the active marker to the next low peak to the right of the current marker.

IEC/IEEE bus command
`:CALCulate<1|2>:MARK<1...4>:MIN:RIGHt`
`:CALCulate<1|2>:DELT<1...4>:MIN:RIGHt`

NEXT MIN LEFT

The *NEXT MIN LEFT* softkey sets the active marker to the next low peak to the left of the current marker.

IEC/IEEE bus command
`:CALCulate<1|2>:MARK<1...4>:MIN:LEFT`
`:CALCulate<1|2>:DELT<1...4>:MIN:LEFT`

PEAK EXCURSION

The *PEAK EXCURSION* softkey activates the entry the minimum amount a signal level must decrease/increase before it is recognised by the search functions (except PEAK and MIN) as a maximum or minimum.

The entry range is 0 dB to 80 dB with a resolution of 0.1 dB.

IEC/IEEE bus command
`:CALCulate<1|2>:MARKer<1..4>:PEXCursion 10DB`

The peak excursion is preset to 6 dB. This is sufficient for the functions *NEXT PEAK* (or *NEXT MIN*) as the next smallest (or highest) signal is always searched four.

Functions *NEXT PEAK LEFT* and *NEXT PEAK RIGHT* (or *NEXT MIN LEFT and NEXT MIN RIGHT*) search for the next relative maximum (or minimum) irrespective of the current signal amplitude.
As for wide bandwidths, the set 6-dB level change is already reached by the noise indication of the receiver, the noise values are also identified as peak. In this case, a value for *PEAK EXCURSION* which is greater than the difference between the maximum and minimum noise display reading must be entered.

The following example shows the effect of different *PEAK EXCURSION* settings.

Fig. 4-9 Example: level measurements at various peak excursion settings

Maximum relative level change of the measured signals:

Signal 2:	42dB
Signal 3	30dB
Signal 4:	46dB

With **Peak Excursion 40dB** signal 2 and 4 are detected by *NEXT PEAK* or *NEXT PEAK RIGHT*. Signal 3 is not detected since it is only decreased by 30 dB before rising again.

Order in which signals are found:

PEAK:	Signal 1	or	PEAK:	Signal 1
NEXT PEAK:	Signal 2		NEXT PEAK RIGHT:	Signal 2
NEXT PEAK:	Signal 4		NEXT PEAK RIGHT:	Signal 4

With **Peak Excursion 20dB** signal 3 is detected since its highest level change of 30 dB is now higher than the peak excursion.

Order in which signals are found:

PEAK:	Signal 1	or	PEAK:	Signal 1
NEXT PEAK:	Signal 2		NEXT PEAK RIGHT:	Signal 2
NEXT PEAK:	Signal 4		NEXT PEAK RIGHT:	Signal 3
NEXT PEAK:	Signal 3		NEXT PEAK RIGHT:	Signal 4

With **Peak Excursion 6dB** all the signals are detected, *NEXT PEAK RIGHT* does not produce the required results.

Order in which signals are found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2

`SEARCH LIM ON OFF`

The *SEARCH LIMIT ON/OFF* softkey toggles between a limited (*ON*) and unlimited (*OFF*) search range.

For peak and min. search functions, the search range can also be limited by the frequency lines (FREQUENCY LINE 1, 2). If *SEARCH LIMIT = ON*, the appropriate signal level will only be searched for between the specified frequency lines.

The default setting is *SEARCH LIMIT = OFF*.

When only one line is enabled, frequency line 1 is defined as the lower limit and the upper limit is defined by the stop frequency. If frequency line 2 turned on, then it determines the upper limit.

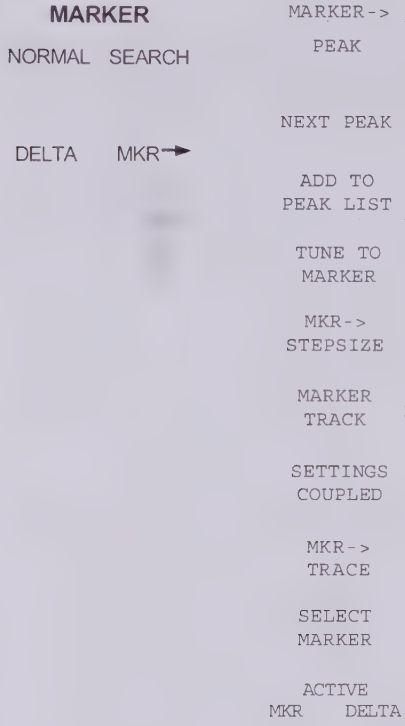
For the case in which no line is active the search range is unlimited.

IEC/IEEE bus command

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits ON|OFF
```

Instrument Parameter Changes via Markers – MKR → Key

MARKER MKR →menu:



The *MKR* → menu offers functions through which instrument parameters can be changed with the aid of the currently active marker. Exactly as in the *SEARCH* menu, these functions can also be applied to the delta markers.

The choice between marker and delta marker is made according to the currently active frequency entry mode for the marker/delta marker. If no entry mode is active, the marker with the lowest number will be activated as the reference marker.

To simplify control, the functions *PEAK, NEXT PEAK, TUNE TO MARKER, MARKER TRACK, SETTINGGS COUPLED, SELECT MARKER* and *ACTIVE MKR DELTA* are also available in the *MRK→* menu. Thus, the most important functions can be selected in one menu (see section "Search Functions - *SEARCH Key"* for these softkeys).

ADD TO PEAK LIST

The *ADD TO PEAK LIST* softkey adds the receiver frequency of the current marker to the peak list (see also Section "Data Reduction and Subrange Maxima").

IEC/IEEE bus command --

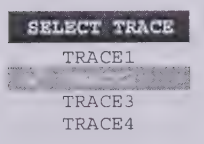
MKR-> STEPSIZE

The *MKR→STEPSIZE* softkey sets the step size for the receiver frequency to the current marker frequency.

IEC/IEEE bus command
```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:CSTep
```

MKR-> TRACE

The *MKR→TRACE* softkey opens a selection window through which the marker can be set on a new trace. The traces available for selection appear in the window.



IEC/IEEE bus command
```
:CALCulate<1|2>:MARKer<1..4>:TRACe 2
:CALCulate<1|2>:DELT<1..4>:TRACe 2
```

Setup of Display and Limit Lines – *LINES* Key Field

Display Lines – *D LINES Key*

Display lines are aids which, similar to markers, make the evaluation of measurement curve data more convenient. The function of display lines is similar to that of a movable scale which can be used to measure absolute and differential values on measurement curves.
In addition, the display lines can also be used to limit the range of search for marker functions.

The ESI provides four different types of display lines:

- two horizontal threshold lines for setting levels or for defining level search ranges – Display Line 1/2,
- two vertical frequency lines for indicating frequencies or for determining frequency search ranges – Frequency Line 1/2,
- a threshold line which, for example, sets the search threshold for maximum levels (Peak Search) – Threshold Line
- a reference line which serves as the basis for mathematical correlation between measurement curves – Reference Line

For purposes of clarity, each line is annotated on the right side of the display diagram by the following abbreviations:

D1	Display Line 1	TH	Threshold Line
D2	Display Line 2	REF	Reference Line
F1	Frequency Line 1		
F2	Frequency Line 2		

The lines for level, threshold and reference are displayed as continuous, horizontal lines over the full width of the diagram. They are movable in the y-direction.
The lines for frequency are displayed as vertical, continuous lines over the total height of the diagram. They are movable in the x-direction.

Note: *The softkeys for setting and switching the display lines on and off operate similar to a three-position switch:*

Initial condition: The line is switched off (softkey has grey background)

1st press: The line is switched on (softkey has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If some other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (softkey has green background).

2nd press: The display line is switched off (softkey has grey background).

Initial condition: The line is switched on (softkey has green background)

1st press: The line is switched on (softkey has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If any other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (softkey has green background).

2nd press: The display line is switched off (softkey has grey background).

Menu *LINES-D-LINES*

LINES

D LINES

LIMIT

D LINES
DISPLAY LINE 1
DISPLAY LINE 2
THRESHOLD LINE
REFERENCE LINE
FREQUENCY LINE 1
FREQUENCY LINE 2
.
.
.

The *D LINES* key activates the sub menu for setting of the display lines.

DISPLAY LINE 1

The *DISPLAY LINE 1/2 softkeys* switch the display lines on/off and activate the entry of the line location.

The display lines mark the selected levels in the measurement window.

DISPLAY LINE 2

IEC\IEEE bus commands

```
:CALCulate<1|2>:DLINe<1|2>:STATe ON|OFF;
:CALCulate<1|2>:DLINe<1|2> -20dBm
```

THRESHOLD LINE

The *THRESHOLD LINE softkey* switches the threshold line on/off and activates the entry of the line location.

The threshold line is a display line which defines a threshold value. This threshold value serves as a lower search limit for maximums/minimums in the marker functions (*MAX PEAK, MIN PEAK, NEXT PEAK* etc.).

IEC\IEEE bus commands

```
:CALCulate<1|2>:THReshold ON | OFF;
:CALCulate<1|2>:THReshold -82dBm
```

REFERENCE LINE

The *REFERENCE LINE softkey* switches the reference line on/off and activates the entry of the line position.

The reference line serves as the basis for mathematical correlation between measurement curve data (see section "Mathematical Operations on Measurement Curves"

IEC\IEEE bus commands

```
:CALCulate<1|2>:RLINe ON | OFF;
:CALCulate<1|2>:RLINe -10dBm
```

FREQUENCY LINE 1

The *FREQUENCY LINE 1/2 softkeys* switch the frequency lines 1/2 on/off and activate the entry of the line locations.

The frequency lines mark the selected frequencies in the measurement window or define search ranges (see section "Marker Functions").

FREQUENCY LINE 2

IEC\IEEE bus commands

```
:CALCulate<1|2>:FLINe<1|2>:STATe ON | OFF;
:CALCulate<1|2>:FLINe<1|2> 120 MHz
```

Limit Lines – *LIMITS Key*

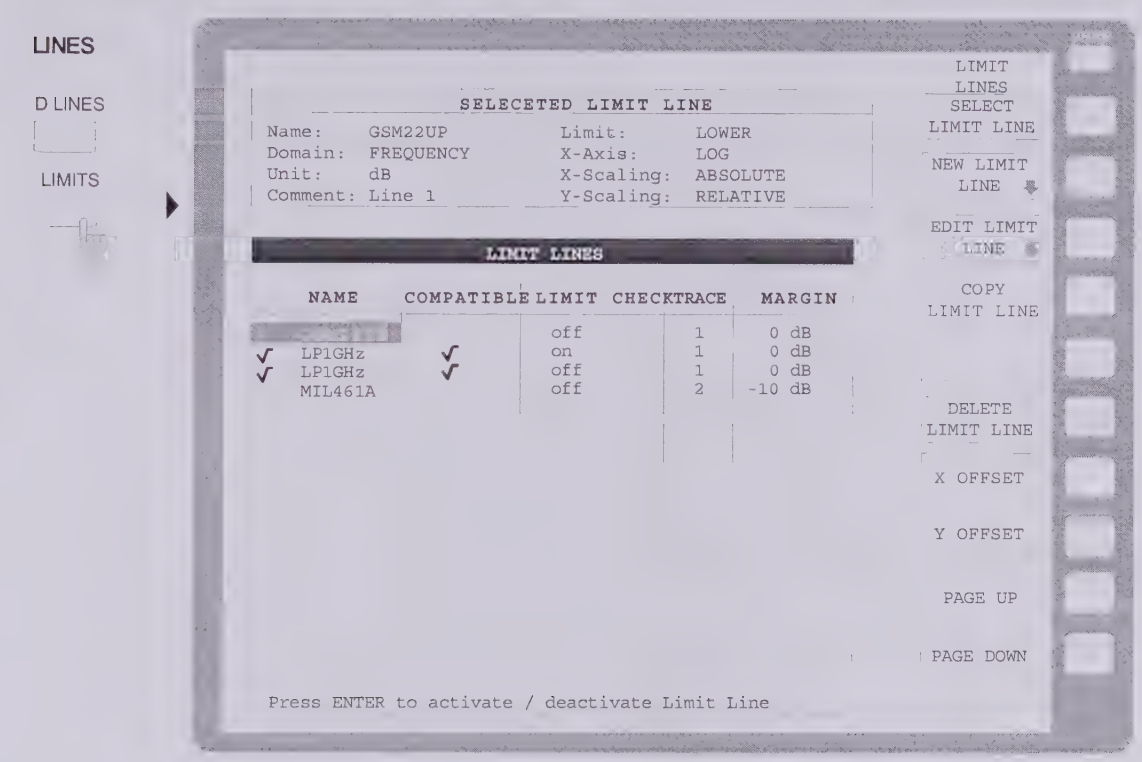
Limit lines are used to define limits to amplitude curves or spectral distributions on the screen. They indicate, for example, the upper limits for spurious emissions from a Unit Under Test (UUT). The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be checked either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The ESI supports up to 300 limit lines, each of which may have a maximum of 50 data points. For each limit line, the following characteristics must be defined:

- The name of the limit line. The limit line is stored under this name and is displayed in the *LIMIT LINES* table.
- The X-coordinates of the interpolation points. In the receiver mode, the limit line is specified for absolute frequencies.
- The Y-coordinates of the interpolation points. In the receiver mode, the limit line is selected for absolute levels.
- The type of limit line (upper or lower limit). With this information and the active limit checking function (*LIMIT CHECK*), the ESI checks for compliance with each limit.
- The limit line units to be used. The units for the limit line must be compatible with the level axis in the active measurement window.
- The trace to which the limit line is assigned. For the ESI, this defines the trace to which the limit is to be applied when several traces are simultaneously displayed.
- For each limit line, a margin can be defined which serves as a threshold for automatic evaluation.
- A comment can also be entered for each limit line, eg, a description of the application.

In the *LINES LIMIT* menu, the compatible limit lines can be enabled in the *LIMIT LINES* table. The *SELECTED LIMIT LINE* display field provides information concerning the characteristics of the marked limit lines. New limit lines can be specified and edited in the *NEW LIMIT LINE and EDIT LIMIT LINE* submenus.

LINES LIMIT menu



Limit Line Selection

The *SELECTED LIMIT LINES* table provides information about the characteristics of the marked limit line :

Name	name
Domain	frequency domain
Limit	upper/lower limit
X-Axis	linear or logarithmic interpolation
X-Scaling	absolute frequencies
Y-Scaling	absolute Y-units
Unit	for vertical scale
Comment	comment

The characteristics of the limit line are set in the *EDIT LIMIT LINE (=NEW LIMIT LINE)* submenu.

Note: *In the receiver mode only frequency domain and absolute scaling of the x and y axis are valid.*

SELECT LIMIT LINE

The *SELECT LIMIT LINE softkey* activates the *LIMIT LINES* table and the selection bar jumps to the uppermost name in the table.

The column heading are as follows:

Name	NAme of limit line to be selected.
Compatible	Indicates if the limit line is compatible with the measurement window of the given trace.
Limit Check *Trace* *Margin*	These functions are not available in the receiver mode. Entries made in these columns are not effective.

***Name and Compatible* - Switching on limit lines**

A maximum of 8 limit lines can be switched on at any one time. A check mark at the left edge of a cell indicates that this limit line is enabled. A limit line can only be enabled when it has a check mark in the *Compatible* column, ie, only when the display mode of the x-axis and the y-axis units are ***identical*** to those of the measurement window.

Note: *In the receiver mode, limit lines are only used in the frequency domain with absolute X and Y scales. The limit line cannot be switched on when other parameters are entered (time domain or relative scale).*

It should be noted that lines with dB scales are compatible with all dB(..) scales for the Y-axis.
If the trace assigned to a line is not switched on, the line is displayed in the window the trace would be displayed in.

If the y-axis unit is changed, all non-compatible limit lines are automatically switched off in order to avoid misinterpretations. The limit lines must be switched on again when the original display mode is restored.

IEC\IEEE bus commands
```
:CALCulate<1|2>:LIMit<1..8>:NAME <string>;
:CALCulate<1|2>:LIMit<1..8>:STATe ON | OFF
```

COPY LIMIT LINE

The *COPY LIMIT LINE softkey* copies the data set of the marked limit line and saves it under a new name. In this way, a new limit line can be easily generated by parallel translation or editing of an existing limit line. The name can be arbitrarily chosen and entered via an entry window (max. of 8 characters).

IEC\IEEE bus command
```
:CALCulate<1|2>:LIMit<1..8>:COPY 1..8|<name>
```

DELETE LIMIT LINE

Pressing the *DELETE LIMIT LINE softkey* erases the selected limit line. Before deletion, a message appears requesting confirmation.

IEC\IEEE bus command `:CALCulate<1|2>:LIMit<1...8>:DELete`

X OFFSET

The *X OFFSET* softkey is not used in the receiver mode.

Y OFFSET

The *Y OFFSET* softkey is not used in the receiver mode.

Entry and Editing of Limit Lines

A limit line is characterized by

- its name
- the domain assignment (frequency)
- the scale in absolute frequencies
- linear or logarithmic interpolation
- the vertical unit
- the vertical scale
- the definition of the limit line as either upper or lower limit.
- the interpolation points for frequency and level

When the limit line is entered, the ESI immediately checks ll limit lines according to rules that guarantee correct operation.

- The frequencies for each interpolation point must be entered in ascending order, however, for any single frequency, two data points may be entered (vertical segment of a limit line).

  The interpolation points are allocated in order of ascending frequency. Gaps are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies need not necessarily be selectable in ESI. A limit line may also exceed the frequency display range. The minimum frequency for an interpolation point is -200 Hz, the maximum frequency is 200 GHz.
- The minimum/maximum value for a limit line is -200 dB/+200 dB for the logarithmic or $10^{-20}/10^{+20}$ or -99.9%/+ 999.9% for the linear amplitude scales.

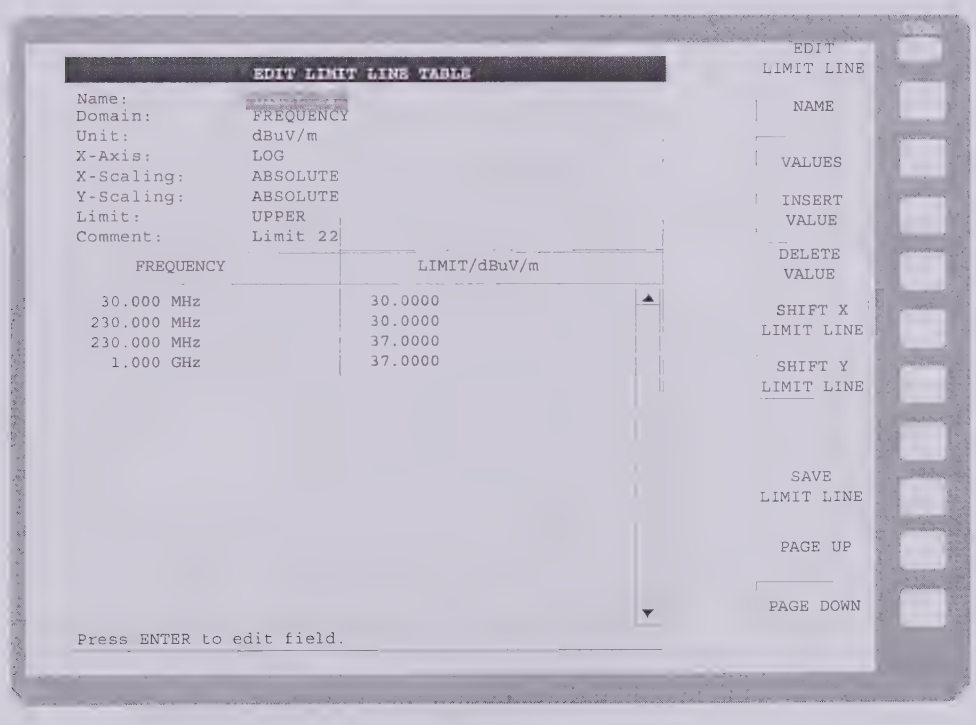
LINES LIMIT-EDIT LIMIT LINE menu

EDIT LIMIT LINE

NEW LIMIT LINE

The *EDIT LIMIT LINE* and *NEW LIMIT LINE softkeys* both call the *EDIT LIMIT LINE* submenu used for editing limit lines. In the table heading, the characteristics of the limit line can be entered. The frequency and level points are entered in the columns.

Name	Enter name.
Domain	Indication of domain.
Unit	Select the units.
X-Axis	Selection of interpolation
X-Scaling	Entry of absolute values for the X-axis
Y-Scaling	Entry of absolute values for the Y-axis
Limit	Select upper/lower limit.
Comment	Enter comments.
Frequency	Enter frequency points.
Limit/dB(..)	Enter level points.



NAME

The *NAME softkey* activates the entry of characteristics in the table heading.

***Name* - Enter name**

A maximum of 8 characters are permitted for each name. All names must be compatible with the MS-DOS conventions for file names. The instrument automatically stores all limit lines with the .LIM extension.

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1...8>:NAME <string>
```

***Domain* - Indication of frequency domain**

In the receiver mode, only frequency domain is used.

***X-Axis* - Indication of interpolation**

Linear or logarithmic interpolation can be carried out between the frequency reference points of the table. Selection is via the ENTER key which is toggled between LIN and LOG (toggle function).

EC-Bus-Befehl

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:SPACing LIN | LOG
:CALCulate<1|2>:LIMit<1..8>:UPPer:SPACing LIN | LOG
:CALCulate<1|2>:LIMit<1..8>:LOWer:SPACing LIN | LOG
```

***Scaling* - Indication of scaling**

In the receiver mode, absolute scaling is used.

X-Scaling ABSOLUTE The frequencies are interpreted as absolute physical units.

Y-Scaling ABSOLUTE The limit values are absolute levels or voltages.

***Unit* - Selecting the vertical scale units for the limit line**

Units are selected in a selection box. The default setting is dBm.

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1...8>:UNIT
DB| DBM| PCT |DBUV| DBMW | DBUA | DBPW|
DBPT | WATT| VOLT | AMPere | DBUV_MHZ |
DBMV_MHZ| DBUA_MHZ | DBUV_M | DBUV_MMHZ
| DBUA_M | DBUA_MMHZ
```

***Limit* - Selecting the upper/lower limit**

A limit line can be defined as either an upper or lower limit.

IEC\IEEE bus command --

```
(defined by the key words :UPPer or :LOWer)
```

***Comment* - Enter comments**

Comments are user selectable, but may not exceed 40 characters in length.

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1..8>:COMMent 'string'
```

VALUES

The *VALUES* softkey activates the entry of the data points in the table columns *Frequency* and *Limit/dB(..)*.

The desired frequency data points are entered in ascending order (two repeated frequencies values are permitted).

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1...8>:CONTrol[:DATA]
                                <num_value>, <num_value>..
:CALCulate<1|2>:LIMit<1...8>:UPPer[:DATA]
                                <num_value>, <num_value>..
:CALCulate<1|2>:LIMit<1...8>:LOWer[:DATA]
                                <num_value>,<num_value>..
```

INSERT VALUE

The *INSERT VALUE* softkey creates an empty line above the current cursor position where a new data point can be entered. However, when entering new values, the ascending order for frequency values must be kept.

IEC\IEEE bus command --

DELETE VALUE

The *DELETE VALUE* softkey erases the data point (complete line) at the cursor position. All succeeding data points are shifted down accordingly.

IEC\IEEE bus command --

SHIFT X LIMIT LINE

The *SHIFT X LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted horizontally direction.

The shift units are the same as the the horizontal scale units: Hz, kHz, MHz or GHz.

This means that it is easy to create a new limit line from an existing limit line which has been shifted horizontally and stored (*SAVE LIMIT LINE softkey*) under a new name (*NAME softkey*).

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:SHIFt 50kHz
```

SHIFT Y LIMIT LINE

The *SHIFT Y LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted vertically.

The shift takes place in dB.

This means that a new limit line can easily be created from an existing limit line which has been shifted vertically and stored (*SAVE LIMIT LINE softkey*) under a new name (*NAME softkey*).

IEC\IEEE bus command

```
:CALCulate<1|2>:LIMit<1..8>:UPPer:SHIFt 20dB
:CALCulate<1|2>:LIMit<1..8>:LOWer:SHIFt 20dB
```

SAVE LIMIT LINE

The *SAVE LIMIT LINE softkey* stores the currently edited limit line . The name can be entered in an entry window (max. 8 characters)

IEC\IEEE bus command -- (automatically executed during remote control)

Trace Selection and Setup –*TRACE Key Group*

The ESI can display up to four separate traces at the same time. A trace has a maximum of 500 pixels along the horizontal frequency axis. If there are more measurement values than pixels available, then several measurement values are assigned to one pixel.

The traces are selected using keys 1 to 4 of the *TRACES* key group.

The traces can be individually enabled for a measurement and, after the measurement is completed, be frozen. Traces which are not enabled remain blanked.

A display mode ican be selected for each trace. The traces can be overwritten (CLEAR/WRITE mode) after each sweep, or the maximum/ minimum over several sweeps can be displayed.

Individual detectors are selectable for the various traces. The peak detector displays the maximum values represented by a pixel. The quasi peak detector displays the value of the level at a pixel weighted according to CISPR. The rms detector displays the power (rms value) of the measured values represented by a pixel, the average detector the linear average value.

The maximum number of measured frequencies which can be measured is limited and depends on the number of the traces which are switched on.

Number of traces	Measured values /trace
1	250.000
2	150.000
3	100.000
4	80.000

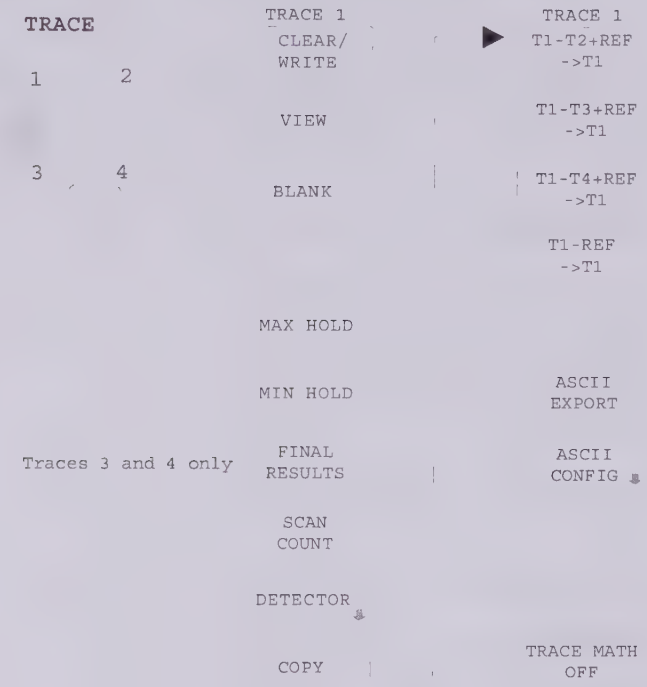
They are stored for postprocessing. If the scan subranges are defined so that more than the possible values would be measured, a respective message is output upon the scan start. Afterwards the scan is performed up to the maximum value.

Measurement Function Selection - *TRACE 1 to 4* key

The trace functions are categorized as follows:

- type of trace display (CLEAR/WRITE, VIEW and BLANK)
- evaluation of the trace as a whole (MAX HOLD and MIN HOLD)
- detector of a trace (PEAK, QUASI PEAK, RMS, AVERAGE and AC VIDEO (AC VIDEO with option ESI-B1 only)

TRACE 1 menu



The *TRACE* keys 1...4 call a menu which presents the setting options for the selected trace.

This menu is used to determine how the measured data will be represented in the frequency domain using the 500 pixels provided by the display.
When the measurement is started, a new trace can be displayed or the trace can be based on previous results.

Traces can be displayed, blanked and copied. By applying mathematical functions, the traces can also be corrected. The measurement detector for each of the display types may be chosen directly by the ESI.

All activated traces are marked with a LED at the corresponding key (here, *TRACE 1)*. The default setting is *TRACE 1* with *CLEAR / WRITE* and the *PEAK* detector selected, *TRACE2* with *CLEAR / WRITE* and the *AVERAGE* detector selected . The remaining traces 3 to 4 are switched off (*BLANK*).

The *CLEAR/WRITE, MAX HOLD, MIN HOLD, VIEW,* and *BLANK* are mutually exclusive selection switches.

CLEAR/ WRITE

The *CLEAR/WRITE* softkey activates the clear/write display mode.

The trace is displayed without additional trace evaluation. The trace memory is overwritten by each scan. If more than one data point falls within a pixel, the trace is displayed in bar form with the maximum and minimum values in a pixel connected. In the clear/write display mode, all the available detectors are selectable.

Whenever the *CLEAR/WRITE* softkey is pressed, the ESI clears the selected trace memory and restarts the measurement.

IEC\IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE WRITe
```

VIEW

The *VIEW* softkey freezes the current contents of the trace memory and displays them.

If, in the *VIEW* display mode, the level display range (*LEVEL RANGE*) is changed, the ESI automatically adapts the measured data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

IEC\IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE VIEW
```

BLANK

The *BLANK* softkey removes the trace from the display screen. However, the trace data remain stored in memory and can be displayed again by *VIEW*. The markers for the blanked trace are also erased. If the trace is activated again (with *VIEW, CLEAR / WRITE, MAX HOLD, MIN HOLD*) the markers will be restored to their original positions.

IEC\IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4> OFF
```

MAX HOLD

The *MAX HOLD* softkey activates the max hold function.

In this display mode, the ESI saves for each scan the largest of the previously stored/currently measured values in the trace memory. In this way, the maximum value of a signal can be determined over several scans.

This is especially useful for measurement of modulated or pulse-like signals. The signal spectrum is built up scan by scan until all the signal components have been captured.

IEC\IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE MAXH
```

MIN HOLD

The *MIN HOLD* softkey activates the min hold mode.

In this display mode, the ESI saves for each scan the smallest of the previously stored/currently measured values in the trace memory. In this way, the minimum value of a signal can be determined over several scans.

This function is, e.g., useful in making an unmodulated carrier in a mix of signals visible. Noise, interference signals or modulated signals are suppressed by the *MIN HOLD* function while a CW signal maintains a constant level.

IEC\IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE MINH
```

FINAL RESULTS

(only traces 3 and 4)

The *FINAL RESULTS* softkey activates the display of final measurement values. Trace 3 represents the allocated final measurement values referring to trace 1 with the symbol "x" and trace 4 the final measurement values for trace 2 with "+" (see section "Selection of Detectors for Final Measurement").

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE FRESults
```

In *SINGLE SCAN* mode, *RUN SCAN* initiates n single scans. The scans are stopped as soon as the selected number of scans is reached.

SCAN COUNT

The *SCAN COUNT* softkey activates the entry of the number of scans for *SINGLE SCAN*.

The permitted range for *SCAN COUNT* is 1 through 32767. The default setting is 1 scan.

IEC\IEEE bus command `:[SENSe<1|2>:]SWEep:COUNt 10`

DETECTOR ▶

DETECTOR
MAX PEAK
QUASIPEAK
AVERAGE
RMS
MIN PEAK
FINAL MAX PEAK
FINAL QUASIPEAK
FINAL AVERAGE
FINAL RMS
FINAL MIN PEAK

The *DETECTOR* softkey opens a submenu to select the detector.

The detector type may be indepently selected for each trace.

Multiple detection is activated by switching on up to four single detectors.

For description of detector types see Section "Detector Selection" in Analyzer Mode.

The detectors for the final measurement are marked by "FINAL".

Softkey *AC VIDEO* is available only if the instrument is equipped with the linear video output option (option ESI-B1). It replaces softkey *MIN PEAK*.

MAX PEAK

The *MAX PEAK* softkey activates the max peak detector.

IEC\IEEE bus command
`:[SENSe:]DETector[:FUNCtion] POSitive`

QUASIPEAK

The *QUASIPEAK* softkey selects the quasi-peak detector.

The quasi-peak detector yields the maximum detected value weighted to CISPR 16 during the set measurement time. The IF bandwidth is adapted as a function of the frequency range. The coupling of the IF bandwidth to the frequency range can be cancelled using softkey *QP RBW UNCOUPLED* in the *EMI RECEIVER DETECTOR* menu.

IEC/IEEE-bus command
`:[SENSe:]DETector[:FUNCtion] QPEak`

AVERAGE

The *AVERAGE* softkey activates the average detector.

The average detector supplies the straight average of the signal during the measurement time.

IEC\IEEE bus command

```
:[SENSe:]DETector[:FUNCtion] AVERage
```

RMS

The *RMS* softkey activates the rms detector.

The rms detector supplies the rms value of the signal. The mean of squares of all sampled values is formed during the measurement time.

IEC\IEEE bus command

```
:[SENSe:]DETector[:FUNCtion] RMS
```

MIN PEAK

The *MIN PEAK* softkey activates the min peak detector.

IEC\IEEE bus command

```
:[SENSe:]DETector[:FUNCtion] NEGative
```

AC VIDEO

The *DETECTOR AC VIDEO* softkey activates the *AC VIDEO* detector. The softkey is available only if the instrument is equipped with the linear video output option (option ESI-B1).

IEC\IEEE bus command

```
:[SENSe:]DETector[:FUNCtion] ACVideo
```

FINAL MAX PEAK

The *FINAL MAX PEAK* selects the max peak detector for the final measurement.

IEC\IEEE bus command

```
:[SENSe:]DETector:FMEasurement POSitive
```

FINAL QUASIPEAK

The *FINAL QUASIPEAK* selects the quasi peak detector for the final measurement.

IEC\IEEE bus command

```
:[SENSe:]DETector:FMEasurement QPEak
```

FINAL AVERAGE

The *FINAL AVERAGE* selects the average detector for the final measurement.

IEC\IEEE bus command

```
:[SENSe:]DETector:FMEasurement AVERage
```

FINAL RMS

The *FINAL RMS* selects the rms detector for the final measurement.

IEC\IEEE bus command

```
:[SENSe:]DETector:FMEasurement RMS
```

FINAL MIN PEAK

The *FINAL MIN PEAK* selects the min peak detector for the final measurement.

IEC\IEEE bus command
`:[SENSe:]DETector:FMEasurement NEGative`

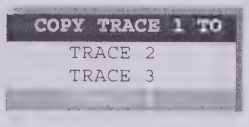
FINAL AC VIDEO

The *FINAL AC VIDEIO* selects the AC video detector for the final measurement. The softkey is available only if the instrument is equipped with the linear video output option (option ESI-B1).

IEC\IEEE bus command
`:[SENSe:]DETector:FMEasurement ACVideo`

COPY..

The *COPY* softkey copies the current trace as displayed on the screen to another trace memory. A table appears in which the desired copy procedure can be selected.



Copying overwrites the contents of the selected memory and the new contents are displayed in view mode.

IEC\IEEE bus command `:TRACe:COPY TRACE1 | TRACE2 | TRACE3 | TRACE4, TRACE1 | TRACE2 | TRACE3 | TRACE4`

Mathematical Functions for Traces

TRACE 1- menu:

TRACE MATH
T1-T2+REF
-> T1

T1-T3+REF
-> T1

T1-T4+REF
-> T1

T1-REF
->T1

The *T1-T2+REF*, *T1-T3+REF*, *T1-T3+REF* and *T1-REF* softkeys subtract the corresponding traces and add the set level to the difference. If the reference line is switched on (see key D LINES), the level value of the reference line is added to the difference. Thus, the differential curve can be positioned anywhere on the screen by shifting the reference line. The difference of the two traces with respect to the reference line is displayed.

The *T1-REF* softkey subtracts the level of the reference line from the trace level.

To indicate that the trace is a difference trace, an enhancement label is displayed at the right margin of the diagram (1-2, 1-3, 1-4, 1-R). In *TRACE 1* main menu, the *TRACE MATH* softkey is illuminated to show that the function is being used.

TRACE MATH
OFF

The *TRACE MATH OFF* softkey switches the difference function off.

ASCII Export for Trace data

TRACE 1- menu:

ASCII EXPORT

The *ASCII EXPORT* softkey stores the active trace in a file with ASCII format. Upon pressing the ASCII EXPORT softkey, a file name can be entered. The default name is TRACE.DAT. Then the measured data of the trace are stored. The function can be configured in the *ASCII CONFIG* submenu.

IEC\IEEE bus command :MMEMory:STORe:TRACe <path>

ASCII CONFIG

ASCII CONFIG
EDIT PATH
DECIM SEP
. ,
NEW
APPEND
HEADER
ON OFF
ASCII
COMMENT
.
.
.

In the *ASCII CONFIG* submenu, various settings for the *TRACE ASCII EXPORT* function can be made.

EDIT PATH

The *EDIT PATH* softkey defines the directory in which the file is to be stored.

IEC/IEEE-bus command --

DECIM SEP

The *DECIM SEP* softkey selects the separator for the ASCII file: '.' (decimal point) or ',' (comma).
This means that the decimal separator used in various language versions of evaluation programs (e.g. MS-Excel) can be selected so that the packages are supported.

IEC/IEEE-bus command
:FORMat:DEXPort:DSEParator POINt|COMMA

NEW
APPEND

The *APPEND NEW* softkey defines whether output data are to be written to an existing file or a new file.

- With *APPEND*, the data are added to an existing file.
- With *NEW*, either a new file is generated or an existing file is overwritten by storage of the data.

IEC/IEEE-bus command
:FORMat:DEXPort:APPend ON | OFF

EDIT
ON OFF

The *HEADER ON/OFF* softkey defines whether important instrument settings should be stored at the beginning of the file.

IEC/IEEE-bus command

```
:FORMat:DEXPort:HEADer ON | OFF
```

ASCII
COMMENT

The *ASCII COMMENT* softkey activates the entry of commentary concerning the current ASCII data set. A total of 60 characters are available for this purpose.

IEC\IEEE bus command

```
:FORMat:DEXPort:COMMent 'string'
```

Structure of the ASCII file:

The file consists of a header containing important scaling parameters and a data section containing the trace data.

There are three columns of data in the file header, each separated by a semicolon ";":
parameter name; numeric value; basic unit

The data section starts with the keyword " Trace <n> " (<n> = number of stored trace), followed by the measured data in one or several columns (depending on the measurement) which are also separated by a semicolon ",".

This format can be read in from spreadsheets, eg MS-Excel. It is necessary to define ';' as a separator.

	Content of file	Description
File header	Type;ESI 7;	Instrument model
	Version;2.07;	Firmware version
	Date;01.Jan 2000;	Date of data set storage
	Mode;Receiver;	Instrument mode
	Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz
	x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
	Detector;AVERAGE;	Selected detector MAX PEAK,MIN PEAK,RMS,AVERAGE, QUASI PEAK,AC VIDEO
	Scan Count;1;	Scan count
	Transducer;TRD1;	Transducer name (if switched on)
	Scan 1:	Loop over all defined scan ranges (1-10)
	Start;150000;Hz	Range - start frequency in Hz
	Stop;1000000;Hz	Range – stop frequency in Hz
	Step;4000;Hz	Range - step width in Hz for linear step width or in % (1-100) for logarithmic step width
	RBW;100000;Hz	Range - resolution bandwidth
	Meas Time;0.01;s	Range - measurement time
	Auto Ranging;ON;	Auto ranging on - or off for current range
	RF Att;20;dB	Range - input attenuation
	Auto Preamp;OFF;	Auto Preamp on or off for current range
	Preamp;0;dB	Range - preamplifier on (20dB) or off (0dB)
	Input;1;	Range - input (1 or 2)
Data section of the file	Trace 1:	Selected trace
	Trace Mode;AVERAGE;	Trace mode: CLR/WRITE,AVERAGE,MAX HOLD,MIN HOLD, VIEW, BLANK
	x-Unit;Hz;	Unit of x values:
	y-Unit;dBuV;	Unit of y values:
	Values;31714;	Number of test points
		Measured values:
	150000.000000;11.459816; 154000.000000;13.225037; 158000.000000;12.387199; 162000.000000;13.124626; 166000.000000;13.615486; ...;...;	<x value>, <y value>;

Example for exported scan data:

```
Type;ESI 7 ;
Version;2.07;
Date;01.Jan 2000;
Mode;Receiver;
Start;150000.000000;Hz
Stop;1000000000.000000;Hz
x-Axis;LOG;
Detector;MAX PEAK;
Scan Count;1;
Transducer;;
Scan 1:
Start;150000.000000;Hz
Stop;30000000.000000;Hz
Step;4000.000000;Hz
RBW;9000.000000;Hz
Meas Time;0.001000;s
Auto Ranging;OFF;
RF Att;10.000000;dB
Auto Preamp;OFF;
Preamp;0.000000;dB
Input;1;
Scan 2:
Start;30000000.000000;Hz
Stop;1000000000.000000;Hz
Step;40000.000000;Hz
RBW;120000.000000;Hz
Meas Time;0.000100;s
Auto Ranging;OFF;
RF Att;10.000000;dB
Auto Preamp;OFF;
Preamp;0.000000;dB
Input;1;
TRACE 1:
Trace Mode;CLR/WRITE;
x-Unit;Hz;
y-Unit;dBuV;
Values;31714;
150000.000000;11.459816;
154000.000000;13.225037;
158000.000000;12.387199;
162000.000000;13.124626;
166000.000000;13.615486;
.....
.....
999880000.000000;24.259178;
999920000.000000;25.103134;
999960000.000000;28.462601;
1000000000.000000;28.185074;
```

If all traces are to be stored in one file with the header information stored only once, the following procedure is recommended:

[TRACE 1] [MENU ⇒][ASCII CONFIG]	
[ASCII CONFIG] [NEW]	Generate new file
[ASCII CONFIG] [HEADER ON]	with header
[TRACE 1] [MENU ⇒][ASCII EXPORT]	Store trace 1 with header
[TRACE 2] [MENU ⇒][ASCII CONFIG]	
[ASCII CONFIG] [APPEND]	Append to end of file
[ASCII CONFIG] [HEADER OFF]	without header
[TRACE 2] [MENU ⇒][ASCII EXPORT]	Write trace 2 to file
[TRACE 3] [MENU ⇒][ASCII EXPORT]	Write trace 3 to file
[TRACE 4] [MENU ⇒][ASCII EXPORT]	Write trace 4 to file

Scan Control – *SWEEP Key Group*

Using the *SWEEP* key group, the parameters are entered which determine the scan characteristics. These are the scan range (*SCAN* key), the trigger used for starting the scan (*TRIGGER* key) and the starting of the scan (*RUN* key).

Entry of Scan Data – *SCAN* Key

SWEEP SCAN menu:

SWEEP
TRIGGER
SWEEP/ SCAN
R
VBW
SWT
COUPLING/ RUN

The *SCAN* key opens a submenu where existing scan tables can be edited or new ones created. Tables with the current scan settings are displayed (see section "Entry of Scan Data").

Start of Frequency Sweep – *RUN* Key

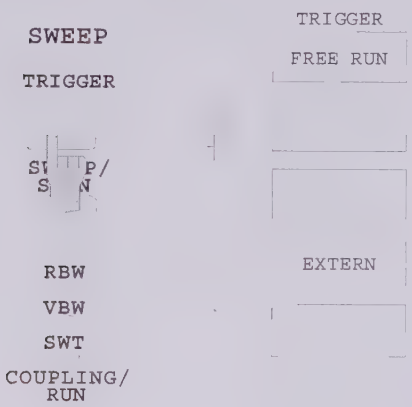
SWEEP RUN menu

SWEEP
TRIGGER
SWEEP/ SCAN
RBW
VBW
SWT
COUPLING/ RUN

The *RUN key* starts the frequency scan with the selected settings (see section "Running a Scan").

Triggering a Level Measurement – *TRIGGER* Key

SWEEP TRIGGER menu



The *TRIGGER* key opens a menu for selecting the various trigger sources and the trigger polarity. The active trigger mode is indicated by illumination of the corresponding softkey.

The *FREE RUN* and *EXTERN* softkeys are selection switches. Only one key can be enabled at any one time (illuminated).

If triggering has taken place, the trigger LED is turned on and then turned off at the end of level measurement.

To indicate that the ESI is set for triggering (= not free run), the enhancement label **TRG** is displayed on the screen.

`FREE RUN`

The *FREE RUN* softkey activates the free-run level measurement (default setting).
With free-run level measurement selected, the start of a scan is not explicitly triggered. Once a measurement is completed, another is started immediately.

IEC\IEEE bus command

```
:TRIGger<1|2>[:SEQuence]:SOURce  IMMediate
```

`EXTERN`

The *EXTERN* softkey activates triggering by an external voltage (-5V to +5V) at the input connector *EXT TRIGGER/GATE* on the rear panel. The trigger threshold can be set in an entry window within this range.

IEC\IEEE bus command

```
:TRIGger<1|2>[:SEQuence]:SOURce EXTernal
:TRIGger<1|2>[:SEQuence]:LEVel 2.5V
```

`SLOPE`
`POS NEG`

The *SLOPE POS/NEG* softkey selects the trigger slope.

The measurement starts after a positive or negative trigger signal edge. The selected setting is illuminated. The selection is valid for all trigger modes with the exception of *FREE RUN*.

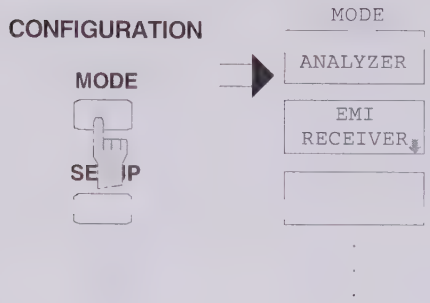
The default mode is *SLOPE POS*.

IEC\IEEE bus command

```
:TRIGger<1|2>[:SEQuence]:SLOPe POS |NEG
```

Analyzer Mode

The analyzer mode is activated in the *CONFIGURATION MODE* menu (see also Section 'Mode Selection - *MODE* Key)



The *ANALYZER* softkey selects the *ANALYZER* mode.

The functions provided are those of a conventional spectrum analyzer. The analyzer measures the frequency spectrum over the selected frequency range with the selected resolution and sweep time, or, for a fixed frequency, displays the waveform of the video signal.

IEC/IEEE-bus command

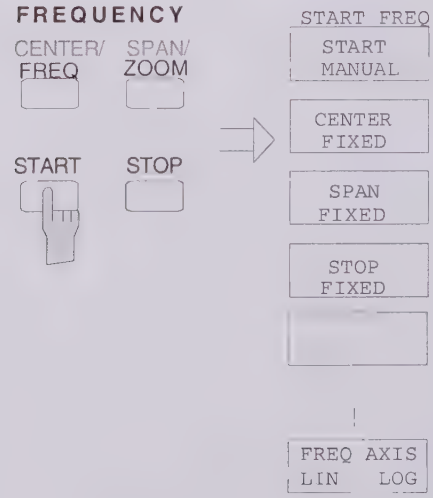
```
:INSTrument<1|2>[:SELect] SANalyzer
```

Frequency and Span Selection – *FREQUENCY* Key Group

The *FREQUENCY* key group is used to specify the frequency axis of the active measurement window. The frequency axis can be defined either by the start and stop frequency or by the center frequency and span. For the case when two measurement windows (*SPLIT-SCREEN)* are displayed simultaneously, data entered are always related to the window selected in the *SYSTEM-DISPLAY* menu.
When one of the keys *CENTER*, *SPAN*, *START* or *STOP* is pressed, its value can be specified in an entry window. At the same time, a softkey menu appears, which allows selecting the optional parameters.

Start Frequency – *START* Key

FREQUENCY – START menu:



The *START* key opens a menu which displays the various options for setting the start frequency of the sweep. The *START MANUAL* softkey is automatically active and opens the entry window for manual input of the start frequency. At the same time, the coupling of the parameters is set to *STOP FIXED*

The *STOP FIXED, SPAN FIXED* and *CENTER FIXED* softkeys are mutually exclusive selection switches. Only one of these switches may be active at any one time. The frequency coupling selected by the softkeys defines which of the dependent parameters stop frequency, center frequency and span is to remain constant when a change in the start frequency is made.

The *FREQ AXIS LIN/LOG* softkey switches between linear and logarithmic scaling of the frequency axis.

The *START MANUAL* softkey activates manual entry of the start frequency.

The allowed range of values for the start frequency is:

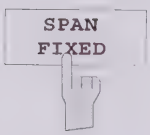
$0\ Hz <= f_{start} <= f_{max} - minspan/2$

f_{start} start frequency
minspan smallest selectable span)
f_{max} max. frequency

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:STARt 20 MHz`

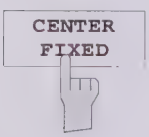
If the *STOP FIXED* key is active, the stop frequency remains constant when the start frequency is changed. The center frequency is adjusted to the new frequency range. *STOP FIXED* coupling is the default setting.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STARt:LINK STOP`



If the *SPAN FIXED* softkey is active, the span remains constant when the start frequency is changed. The stop frequency is adjusted to the new frequency range.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STARt:LINK SPAN`



If the *CENTER FIXED* softkey is active, the center frequency remains constant when the start frequency is changed. The stop frequency is adjusted to the new frequency range.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STARt:LINK CENTer`

The *FREQ AXIS LIN/LOG* softkey switches between linear and logarithmic scaling of the frequency axis.

When the log scale is used, the following restrictions apply:

- For the start/stop frequency ratio the following holds:

$$\frac{Stopfrequency}{Startfrequency} \geq 1.4$$

  At ratios below 1.4, a linear frequency scale is automatically selected.

- Up to five decades can be set.

$$\frac{Stopfrequency}{Startfrequency} \leq 10^5$$

  When the start or stop frequency is changed, the stop or start frequency is adapted to the settable range, as required.

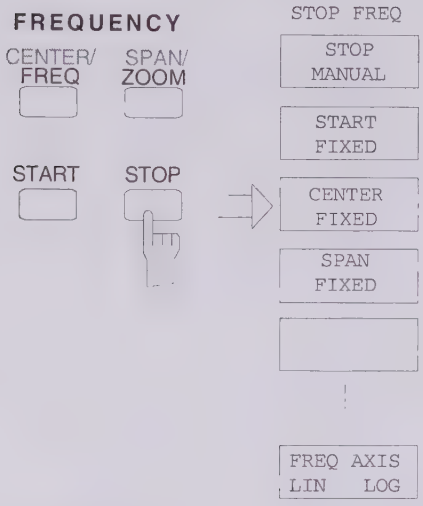
- A frequency offset is not allowed.
- The *CHANNEL POWER, C/N, C/N0, ADJACENT CHAN POWER* and *OCCUPIED PWR BANDW* measurements are disabled.

Note: *The function of a limit line is influenced by the FREQ AXIS LIN/LOG setting at the time of the definition.*
Limit lines are entered as tabulated values (level and frequency). Most regulations and standards prescribe the linking of values by straight lines both for the linear and logarithmic display. When the limit line is defined with the desired frequency scale selected, this is automatically taken into account (linear interpolation).
To be able to use the correct limit values among the tabulated values after a scale switchover, the limit line is recalculated after the switchover.

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:SPACing LIN | LOG`

Stop Frequency – *STOP* Key

FREQUENCY – STOP menu:



The *STOP* key opens a menu which displays the various options for setting the stop frequency of the sweep .

The *STOP MANUAL* softkey is automatically active and opens the entry window for manual input of the stop frequency. At the same time, parameter coupling is set to *START FIXED*.

The *START FIXED, CENTER FIXED* and *SPAN FIXED* softkeys are mutually exclusive selection switches. Only one switch can be active at any one time. The softkeys are used to select the frequency coupling. The frequency coupling defines which of the dependent parameters start frequency, center frequency or span is to remain constant when the stop frequency is changed.

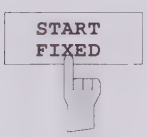
The *STOP MANUAL* softkey activates the manual entry window for the stop frequency.

The allowed range of values for the stop frequency is:

minspan ■ f_{stop} ■ f_{max}

f_{stop} stop frequency
minspan smallest selectable span (10Hz)
f_{max} max. frequency

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:STOP 13 GHz`

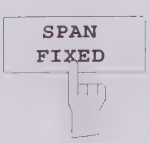


If the *START FIXED* softkey is active, the start frequency remains constant when the stop frequency is changed. The center frequency is adjusted to the new frequency range. The *START FIXED* coupling is the default setting.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STOP:LINK STARt`

If the *CENTER FIXED* softkey is active, the center frequency remains constant when the stop frequency is changed. The start frequency is adjusted to the new frequency range.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STOP:LINK CENTer`



If the *SPAN FIXED* softkey is active, the span remains constant when the stop frequency is changed. The start frequency is adjusted to the new frequency range.

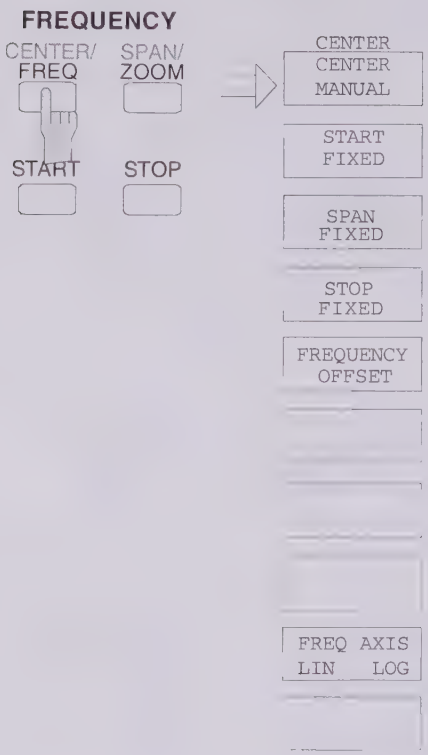
IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:STOP:LINK SPAN`

The *FREQ AXIS LIN/LOG* softkey switches between linear and logarithmic scaling of the frequency axis (see START key).

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:SPACing LIN | LOG`

Center Frequency – *CENTER* Key

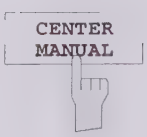
FREQUENCY – CENTER menu:



The *CENTER* softkey opens a menu which displays the various options for setting the center frequency of the sweep.

The *CENTER MANUAL* softkey is automatically active and opens the entry window for manual input of the center frequency. At the same time, the coupling of the parameters is set to *SPAN FIXED*.

The *START FIXED, STOP FIXED* and *SPAN FIXED* softkeys are mutually exclusive selection switches. Only one switch can be active at any one time. The softkeys are used to select the frequency coupling. The frequency coupling defines which of the dependent parameters start frequency, stop frequency or span remains constant when the center frequency is changed.



The *CENTER MANUAL* softkey opens the entry window for entering the center frequency.

The entry range for the center frequency is:

for the frequency domain (span > 0):

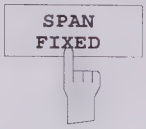
$0\ Hz <= f_{center} <= f_{max} - minspan/2$

and for the time domain (span = 0)

$0\ Hz \blacksquare f_{center} \blacksquare f_{max}$

f_{center}	center frequency
minspan	smallest selectable span (10Hz)
f_{max}	max. frequency

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:CENTer 1.3 GHz`



If the *SPAN FIXED* softkey is active, the span remains constant when the center frequency is changed. The start and stop frequency are adjusted to the new frequency range. *SPAN FIXED* coupling is the default setting.

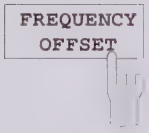
IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:CENTer:LINK SPAN`

If the *START FIXED* softkey is active, the start frequency remains constant when the center frequency is changed. The span is adjusted to the new frequency range.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:CENTer:LINK STARt`

If the *STOP FIXED* softkey is active, the stop frequency remains constant when the center frequency is changed. The span is adjusted to the new frequency range.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:CENTer:LINK STOP`



The *FREQUENCY OFFSET* softkey activates the entry of a straight frequency offset which is added to the frequency axis. The offset range is -100 GHz to 100 GHz. The default setting is 0 Hz.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:OFFSet 10 GHz`

The *FREQ AXIS LIN/LOG* softkey switches between linear and logarithmic scaling of the frequency axis (see START key).

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:SPACing LIN | LOG`

Center Frequency Step Size

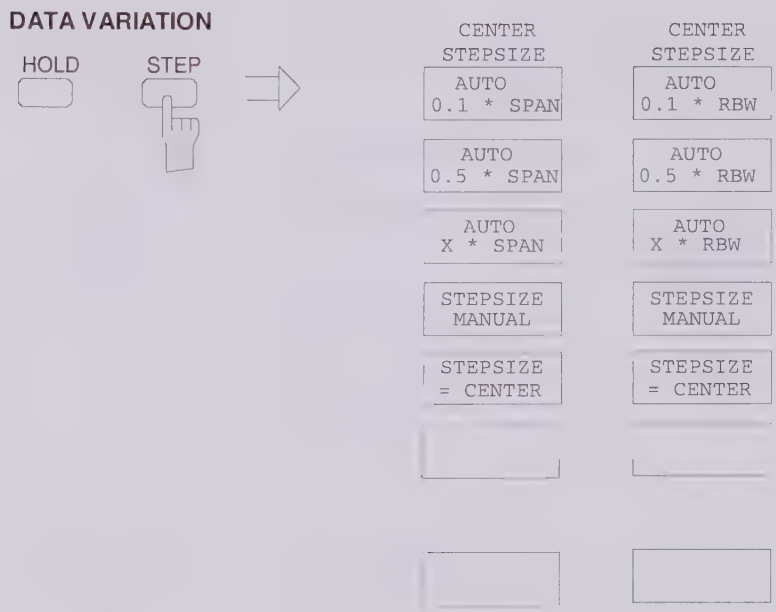
The *STEP* key in the *DATA VARIATION* key group opens a menu for setting the step size of the center frequency. The step size can be coupled to the span (frequency domain) or the resolution bandwidth (time domain) or it can be manually set to a fixed value.

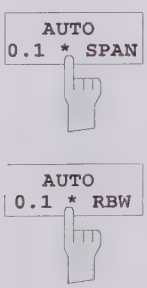
In order to change the step size, the entry window for the center frequency must already be active. After pressing the *STEP* key, the *CENTER STEP* menu appears. The softkeys are presented according to the selected domain (frequency or time).

Only one of the menu softkeys can be activated at any one time.

Control is returned to the *FREQUENCY CENTER* menu via the menu key.

DATA VARIATION - STEP menu for span ■ 0 for span = 0





Frequency domain: The *AUTO 0.1 * SPAN* softkey sets the step size for center frequency entry to 10% of the span.

IEC/IEEE-bus command

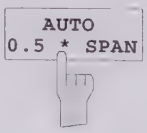
```
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK SPAN;
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK:FACTor 10PCT
```

Time domain: The *AUTO 0.1 * RBW* softkey sets the step size of the center frequency entry to 10% of the resolution bandwidth

IEC/IEEE-bus command

```
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK RBW;
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK:FACTor 10PCT
```

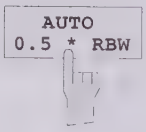
*AUTO 0.1 * RBW* is the default setting.



Frequency domain: The *AUTO 0.5 * SPAN* softkey sets the step size for center frequency entry to 50% of the span.

IEC/IEEE-bus command

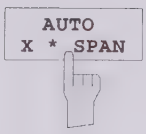
```
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK SPAN;
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK:FACTor 50PCT
```



Time domain: The *AUTO 0.5 * RBW* softkey sets the step size of the center frequency entry to 50% of the resolution bandwidth

IEC/IEEE-bus command

```
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK RBW;
:[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK:FACTor 50PCT
```



Frequency domain:The *AUTO X * SPAN* softkey activates the entry of the factor defining the center frequency step size as a % of span.

IEC/IEEE-bus command see *AUTO 0.5 * SPAN*

Time domain: The *AUTO X * RBW* softkey activates the entry of the factor defining the center frequency step size as a % of the resolution bandwidth.

IEC/IEEE-bus command see *AUTO 0.5 * RBW*

Values between 1 and 100% in steps of 1% are acceptable. The default setting is 10%.

The *STEPSIZE MANUAL* softkey activates the entry window for the input of a fixed step size.

IEC/IEEE-bus command

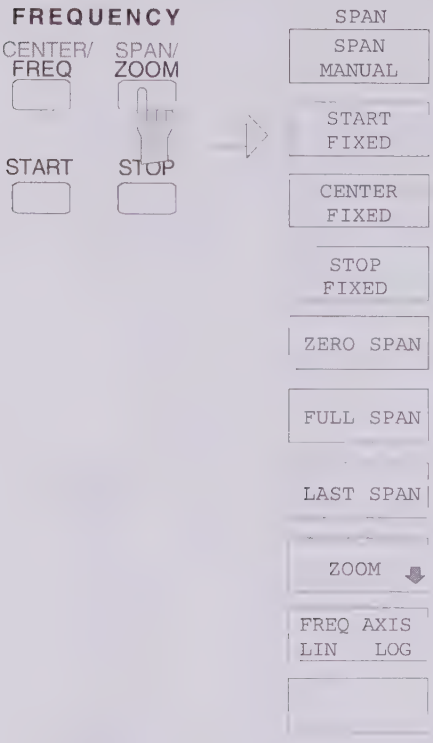
```
:[SENSe<1|2>:]FREQuency:CENTer:STEP 1.3 GHz
```

The *STEPSIZE = CENTER* softkey sets the step size coupling to *MANUAL* and the step size to the center frequency. This function is especially useful when measuring harmonics, because, when the center frequency is entered, each *STEP* key stroke slects the center frequency of the next harmonic.

IEC/IEEE-bus command --

Frequency Span – *SPAN* Key

FREQUENCY – SPAN menu:



The *SPAN* key opens a menu for setting the sweep span.

The *SPAN MANUAL* softkey is automatically active and opens the entry window for manual input of the span. At the same time, the parameter coupling is set to *CENTER FIXED*.

The *START FIXED, CENTER FIXED* and *STOP FIXED* softkeys are mutually exclusive selection switches. Only one switch can be active at any one time. The frequency coupling is selected with these softkeys. The frequency coupling defines which of the dependent parameters start frequency, center frequency or stop frequency is to remain constant when the span is changed

The *SPAN MANUAL* softkey activates the manual entry of the span.

The span entry range is for:
time domain (span = 0):

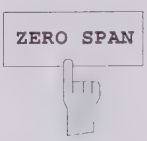
0 Hz

frequency domain (span > 0):

minspan ■ f_{span} ■ f_{max}

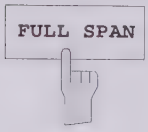
f_{span}	frequency span
minspan	smallest selectable span (10Hz)
f_{max}	max. frequency

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:SPAN 10MHZ`



The *ZERO SPAN* softkey sets the span value to 0 Hz. The x axis becomes the time axis. The axis labelling corresponds to the sweep time (on the left, 0 ms, on the right, the current sweep time (SWT)).

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:SPAN 0HZ`



The *FULL SPAN* softkey sets the span value to the maximum span of the ESI.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQuency:SPAN:FULL`

The *LAST SPAN* softkey restores the previous setting if the span has been changed. This makes it possible to switch over between an overview measurement (*FULL SPAN*) and a detailed measurement (manually set center frequency and span).

The *FULL SPAN* softkey modifies the center frequency as well as the selected span. The *LAST SPAN* softkey cancels this change.

IEC/IEEE-bus command `--`

If the *START FIXED* softkey is activated, the start frequency remains constant when the span is changed. The center and stop frequency are adjusted to the new span.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:SPAN:LINK START`

If the *CENTER FIXED* softkey is activated, the center frequency remains constant when the span is changed. The center and stop frequency are adjusted to the new span. The *CENTER FIXED* coupling is the default setting.

IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:SPAN:LINK CENTer`

If the *STOP FIXED* softkey is activated, the stop frequency remains constant when the span is changed. The center and start frequency are adjusted to the new span.

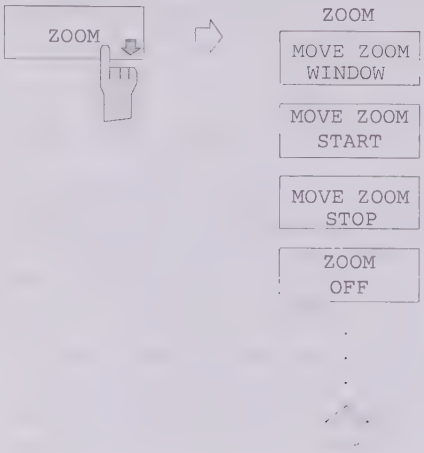
IEC/IEEE-bus command `:[SENSe<1|2>:]FREQ:SPAN:LINK STOP`

The *FREQ AXIS LIN/LOG* softkey switches between linear and logarithmic scaling of the frequency axis (see START key).

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:SPACing LIN | LOG`

Display Zoom

FREQUENCY SPAN- ZOOM submenu:



The *ZOOM* softkey activates the zoom mode and opens a sub-menu to define the zoom span.

Two frequency lines, which show and define the frequency range to be zoomed, appear in the active measurement window when the zoom mode is switched on. The default setting is a zoom span of 10% to the left and 10% to the right of the center frequency. The zoomed display is shown in the second measurement window.
The settings for the second measurement window are taken from the original window. The second measurement window thus becomes the active measurement window and its settings can now be changed.

If only one window is active when the zoom function is selected, *SPLIT SCREEN* mode is automatically switched on.

The zoom span can be edited by using the softkeys of the sub-menu to change the position of the frequency lines.

The softkey ZOOM OFF switches off the zoom.

The *MOVE ZOOM WINDOW* softkey shifts the whole zoom window. The window can shifted until the upper frequency line reaches the stop frequency or the lower frequency line reaches the start frequency of the original window.

IEC/IEEE-bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:ZOOM ON
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X:ZOOM:CENTer 1GHz
```

The *MOVE ZOOM START* softkey shifts the lower frequency line. The start frequency of the zoomed display can then be modified. The frequency line can be shifted to the start frequency of the original window or to the upper frequency line (= zero span).

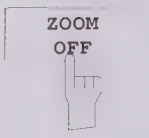
IEC/IEEE-bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:ZOOM ON
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X:ZOOM:STARt 100MHz
```

The *MOVE ZOOM STOP* softkey shifts the upper frequency line. Thus, the stop frequency of the zoomed display can be modified. The frequency line can be shifted to the stop frequency of the original window or to the lower frequency line (= zero span).

IEC/IEEE-bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:ZOOM ON
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X:ZOOM:STOP 200MHz
```



The *ZOOM OFF* softkey switches the zoom function off and then returns control to the main menu.
The frequency lines indicating the zoom range are deleted, *SPLIT SCREEN* mode remains active, the settings of both measurement windows are retained and the coupling of the two measurement windows is cancelled.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:X[:SCALe]:ZOOM OFF
```

Level Display and RF Input Configuration – *LEVEL Key Group*

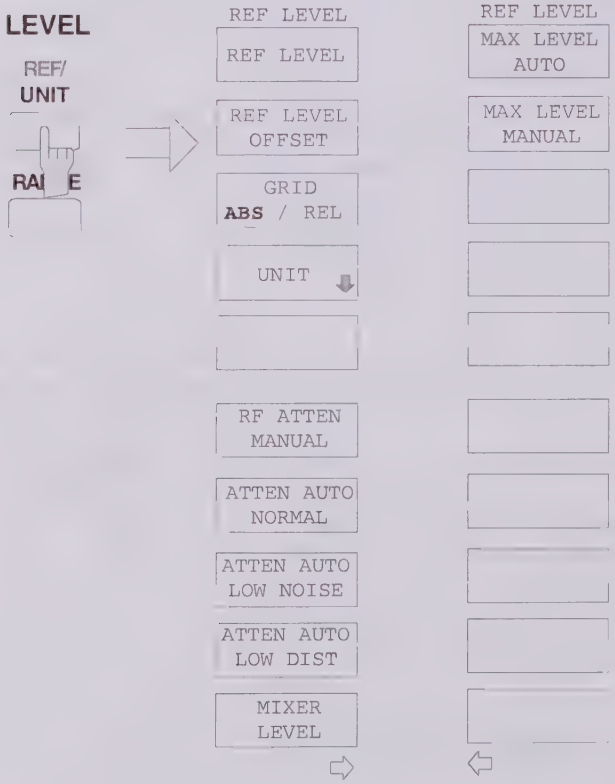
The *REF* and *RANGE* keys are used to set the reference level (= maximum RF input level, = overload limit), the maximum level (= upper grid level) , and the display range of the active window. The *INPUT* key sets the characteristics of the RF input (input impedance, selection of input and input attenuation).

Reference Level – *REF* key

In addition to the reference level (maximum RF input level), the ESI provides a function to define a maximum level (uppermost grid line on the display):
For a spectrum analyzer, the upper boundary of the measurement diagram (maximum level) is also the limit of its dynamic range (reference level). This means, that a signal which goes beyond the upper grid line also overdrives the analyzer.

For compensation of frequency or antenna characteristics, transducer factors can be applied to increase the signal level. In this case, the calculated values can be above the reference level without actually being physically applied to the instrument. In order to display these signals on the grid, an upper grid level which is different from the reference level of the analyzer can be entered.

LEVEL REF menu:



The *REF* key opens a menu to set the reference level and the input attenuation for the active measurement window .

The *REF LEVEL* softkey is automatically active with the menu called up and opens the entry window for manual input of the reference level.

At the same time various settings concerning the level and the attenuation display can be made.

The functions for setting the attenuation are identical to those under the *INPUT* key and are described in Section "Configuration of the RF Input - INPUT Key".

The *REF LEVEL* softkey activates the entry of the reference level. The unit of the entry will be the currently active unit (dBm, dBµV, etc.).

If the *MAX LEVEL MANUAL* softkey is active, a change of the reference level causes an equal amount of change in maximum level Thus, the separation between the overload limit of the analyzer to the upper grid edge remains the same. Thus, with only one entry, it is possible to make a change to the display and simultaneously to perform an adjustment to the amplifier.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:RLEVel -60DBM
```

The *REF LEVEL OFFSET* softkey activates the entry of a straight level offset (±200 dB in 0,1 dB steps). The offset is added to the measured level irrespective of the selected unit. The scaling of the y axis is changed accordingly. The input can be used to take into account an external attenuation.
The setting range is ±200 dB in 0,1-dB steps.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:RLEVel:OFFSet -1dB
```

The *GRID ABS/REL* softkey toggles between absolute and relative scaling of the level axis. *GRID ABS* is the default setting.

For absolute scaling the labeling of the level lines is referenced to the absolute value of the reference level.

For relative scaling, the upper line of the grid is always at 0 dB and the scale units are in dB. In contrast, the reference level is always displayed in the set units (dBm, dB■V,..).

The softkey is not displayed for setting *LIN / %* (linear scaling, labelling in %) in the *LEVEL-RANGE* menu since the % unit itself implies a relative scale.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:MODE  ABS | REL
```

The *MAX LEVEL MANUAL* and *MAX LEVEL AUTO* softkeys are mutually exclusive selection switches. Only one switch can be active at one time. The softkeys are used to select whether reference level and maximum level are identical or not:

When *MAX LEVEL AUTO* softkey is active, the reference level and maximum level are identical.
In this case, the reference level is displayed above the upper left corner of the grid in the corresponding function field.

MAX LEVEL AUTO is the default setting.

If the *MAX LEVEL MANUAL* softkey was active prior to pressing the *MAX LEVEL AUTO* softkey, the upper boundary of the grid is set to the reference level.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:RVALue:AUTO ON
```

The *MAX LEVEL MANUAL* softkey activates the entry of the maximum level. The range of input values is ■ 200dBm with 0.1 dB resolution.

If the *MAX LEVEL MANUAL* softkey is activated, the maximum level is displayed in addition to the reference level to the right above the grid.

IEC/IEEE-bus commands

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:RVALue:AUTO OFF
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:RVALue -20DBM
```

Display Units

Generally, a spectrum analyzer measures the signal voltage at the RF input. The level display is calibrated in terms of therms values of an unmodulated sine wave. In the initial state, the level is displayed at a power of 1 milliwatt (= dBm). As the input impedance is known to be 50Ω or 75Ω, conversion to other units is possible. The units dBm, dBµV, dBµA, dBpW, V, A and W are directly convertible and can be selected in the *REF UNIT* menu.
Units dB../MHz have a special status. They are applicable for broadband pulse signals. The measured pulse voltage or the pulse current is referred to 1 MHz bandwidth. This conversion is not useful for narrowband or sinewave signals.
If the antenna coded connector on the front panel is used, the coded unit there determines the possible display units. Connecting to the coded connector deactivates the settings of the *UNIT* menu.
By certain codings it is nevertheless possible to select a conversion of the unit in the menu.The dependencies between thethe unit of the transducer and the unit which is to be selected for the display are given in the softkey description.

The default coding defined by the connector can be switched off using the *PROBE CODE ON/OFF* softkey. In this case, the unit can be set with the corresponding unit softkeys (dBm, dBµV, ...) even if a coded connector is plugged in. The coded entries in the connector are then ignored.

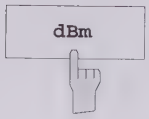
Note: *The units dBµV/m and dBµA/m can only be set via the unit of a transducer or via the unit of the coded connector.*

LEVEL REF UNIT submenu:

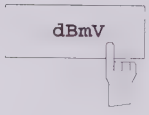
The *UNIT* softkey opens a sub-menu in which the desired units for the level axis can be selectedand.

The selected units are valid for both displays when two measurement windows are displayed.

The unit softkeys are mutually exclusive selection switches. Only one of these switches may be active at any one time.

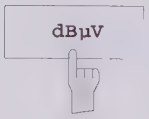


The *dBm, dBµV, dBmV, dBµA, dBpW* softkeys set the display units to the corresponding logarithmic units. The dBm unit is the default unit in analyzer mode.



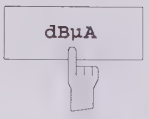
The units *dBm, dBµV, dBmV, dBµA* cannot be selected when the coded antenna connector or the used transducer defines a unit.

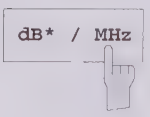
Only for coding dB, the conversion to the desired units is permitted.



IEC/IEEE-bus command

```
:CALCulate<1|2>:UNIT:POWer DBM |DBMV |DBUV |DBUA |DBPW
```





The *dB*/MHz* softkey activates/disactivates the display of results in units relative to the bandwidth. Those units can be derived from the logarithmic units *dBµV, dBµV/m, dBµA* and *dBµA/m.*

This leads to the following relative units:

- *dBmV* ▬ *dBmV/MHz*
- *dBµV* ▬ *dBµV/MHz*
- *dBµV/m* ▬ *dBµV/mMHz*
- *dBµA* ▬ *dBµA/MHz*
- *dBµA/m* ▬ *dBµA/mMHz*

Switching over is possible also if a coded antenna connector or a transducer fixes the unit to be used.

Conversion to 1 MHz is via the pulse bandwidth of the selected resolution bandwidth B_{imp} according to the following equation (example for *dBµV)* :

$$P \;/\; (\mathrm{dB}\mu\mathrm{V}\;(\mathrm{MHz}) = 20 \log \frac{B_{imp}\;/\;\mathrm{MHz}}{1\mathrm{MHz}} + P\;(\mathrm{dB}\mu\mathrm{V}),$$

where P = display level

The dBµV/MHz unit can be combined with the following coded connector or transducer units

dB (the unit dBµV/MHz remains)

µV/m (yields the display unit dBµV/mMHz)

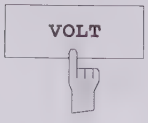
analogous for dBµA/MHz:

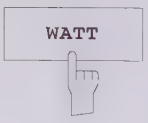
dB and µA (the unit dBµA/MHz remains)

Other combinations are not allowed.

IEC/IEEE-bus command

```
:CALCulate<1|2>:UNIT:POWer DBUV_MHZ|DBUA_MHZ|DBMV_MHZ
```



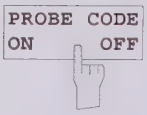


The *VOLT, AMPERE, WATT* softkeys set the display units to the corresponding linear units.

The units *VOLT, AMPERE, WATT* cannot be selected when the coded antenna connector or the transducer table defines one of the following as units:

µV/m
µA

For coding dB, the conversion to the desired units is permitted.

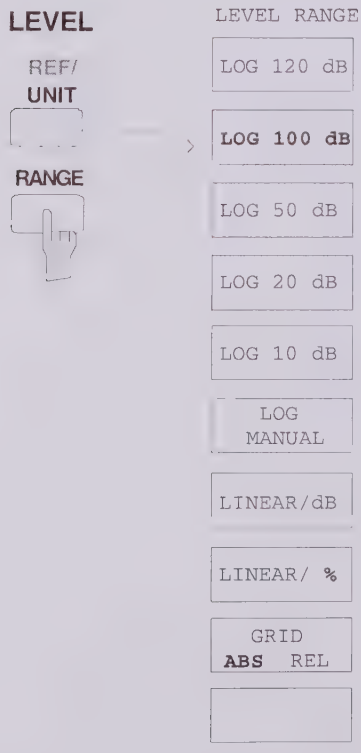


The *PROBE CODE ON/OFF* softkey enables or disables the units defined by the coded connector.

IEC/IEEE-bus command `:UNIT<1|2>:PROBe ON | OFF`

Level Range – *RANGE* Key

LEVEL RANGE menu:



The *RANGE* key calls a menu in which the range, linear or logarithmic the display scale, absolute or relative and the level units for the active window can be selected.

The display range of the analyzer can be set in 10 dB steps from 10 to 200 dB.
The default setting is 100 dB.

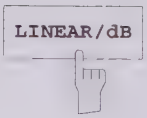
The most often used settings (120 dB, 100 dB, 50 dB, 20 dB and 10 dB) are each directly selectable by a softkey.
All other ranges are chosen with the *LOG MANUAL* softkey.

After pressing the *RANGE* key, the *LOG MANUAL* entry window is enabled if the display range is not set to *LIN*.

The *LOG MANUAL* softkey activates the entry of the level display range. Display ranges from 10 to 200 dB are allowed in 10-dB steps. Values which are not permissible are rounded to the next valid number.

IEC/IEEE-bus commands

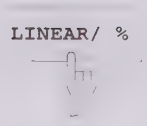
```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing LOG
:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y 110DB
```



The *LINEAR/dB* softkey switches the display range of the analyzer to linear scaling. The horizontal lines are labelled according to the selection *GRID ABS/REL* in dB* or *.

IEC/IEEE-bus command

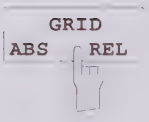
```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing LINear
```



The *LINEAR/%* softkey switches the display range of the analyzer to linear scaling. The horizontal lines are labelled in %. The grid is divided into decades.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:SPACing PERCent
```



The *GRID ABS/REL* softkey switches between absolute and relative scaling of the level axis. *GRID ABS* is the default setting.

ABS The labelling of the level lines is referenced to the absolute value of the reference level.

REL The upper line of the grid is always at 0 dB and the scale units are in dB. In contrast, the reference level is always displayed in the set units (dBm, dB■V,..).

The softkey is not displayed for setting *LIN / %* (linear scaling, labelling in %) since the % unit itself implies a relative scale.

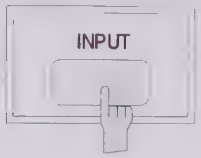
IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y:MODE  ABS | REL
```

RF Input Configuration – *INPUT* Key

In addition to manual entry of the input attenuation, the ESI provides an option which allows the RF attenuation, dependent on the selected reference level, to be automatically set. Thus, it is guaranteed that an optimum combination of RF attenuation and IF amplification is always used. For the automatic selection process, three modes are provided. The *AUTO LOW NOISE* mode selects the amplification/attenuation combination so that the display of noise on the ESI is at a minimum. The signal/noise ratio is maximised. The *AUTO LOW DISTORTION* mode is tuned for minimisation of the internally generated interference products. This causes, however, a lower signal/noise ratio. The *ATTEN AUTO NORMAL* mode is a compromise between low noise and low distortion.
When the instruemnt is equipped with option FSE-B21, External Mixer Output, the ESI26 and ESI40 can be operated with external mixer.

INPUT menu:



INPUT
RF ATTEN MANUAL
ATTEN AUTO NORMAL
ATTEN AUTO LOW NOISE
ATTEN AUTO LOW DIST
MIXER LEVEL
INPUT SELECT
INTERNAL MIXER
EXTERNAL MIXER

The *INPUT* key opens the menu for configuring the RF input. It contains the input attenuator and mixer level for matching the RF input to the input signal.

The *RF ATTEN MANUAL*, *ATTEN AUTO NORMAL*, *ATTEN AUTO LOW NOISE* and *ATTEN AUTO LOW* softkeys are mutually exclusive selection switches. only one can be active at any one time.

Softkeys *INTERNAL MIXER* and *EXTERNAL MIXER* are only available when the ESI is equiped with option FSE-B21, External Mixer Input (see manual of option).

The *INPUT SELECT* softkey calls a submenu for configuration of the RF input

The *RF ATTEN MANUAL* softkey activates the entry of an attenuation factor independent of the reference level.

The following attenuation settings are available, irrespective of which input is active:

- INPUT 1: 0 to 70 dB in 10 dB steps
- INPUT 2: 0 to 70 dB in 5 dB steps

Other inputs will be rounded to the next higher integer value.

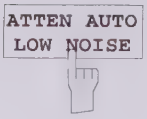
If the defined reference level cannot be set for the given RF attenuation, the reference level will be adjusted accordingly and the warning "Limit reached" will be output.

IEC/IEEE-bus command `:INPut<1|2>:ATTenuation 40DB`

The *ATTEN AUTO NORMAL* softkey sets the RF attenuation automatically as a function of the selected reference level.

IEC/IEEE-bus commands

```
:INPut<1|2>:ATTenuation:AUTO:MODE NORMal
:INPut<1|2>:ATTenuation:AUTO ON
```



The *ATTEN AUTO LOW NOISE* softkey sets the RF attenuation always 10dB lower than in the *RF ATTEN AUTO* mode. Therefore, for 10 dB RF attenuation, the maximum reference level is -10 dBm. For reference levels which are lower, at least 10 dB is always set (see above).

Setting Low Noise means that the indicated inherent noise level is low. This setting is recommended if signals with a low level have to be measured as the highest S/N ratio is then obtained.

IEC/IEEE-bus commands

```
:INPut<1|2>:ATTenuation:AUTO:MODE LNOise
:INPut<1|2>:ATTenuation:AUTO ON
```

The *ATTEN AUTO LOW DIST* softkey sets the RF attenuation 10 dB higher than in *RF ATT AUTO* mode. This means that for 10 dB RF attenuation, the maximum reference level is -30 dBm (-40 dBm at the mixer).

This setting is recommended whenever a small signal is to be measured in the presence of larger signals. Here, the intermodulation-free range of the ESI is large and the internal distortion products are minimised.

IEC/IEEE-bus commands

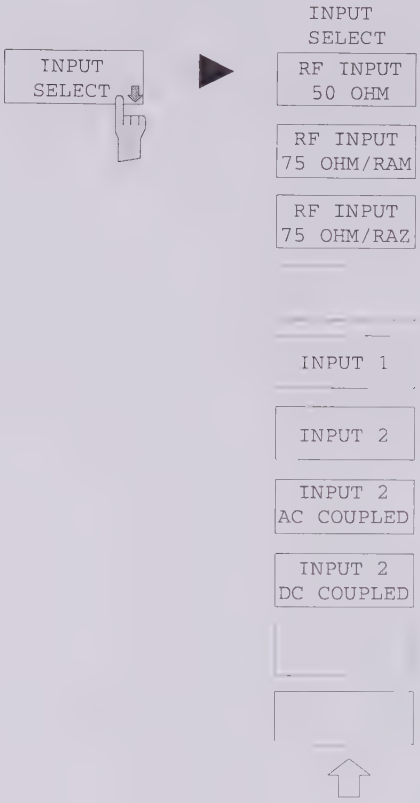
```
:INPut<1|2>:ATTenuation:AUTO:MODE LDIStortion
:INPut<1|2>:ATTenuation:AUTO ON
```

The *MIXER LEVEL* softkey activates the entry of the maximum mixer level attainable for a given reference level. At the same time it enables softkeys *ATTEN AUTO LOW NOISE* and *ATTEN AUTO LOW DIST*.

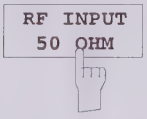
Range of input values is -10 to -100 dBm

IEC/IEEE-bus command `:INPut<1|2>:MIXer -30DBM`

INPUT INPUT SELECT submenu:

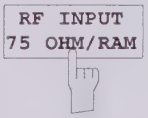


The *INPUT SELECT* softkey calls a submenu for selection an configuration of the RF input. Default setting is 50 Ohm and INPUT 1.
By connecting an impedance converter RAM or RAZ ahead, the 50-Ohm input can be transformed to 75 Ohm. ESI automatically takes the corresponding correction values for the level display into account.
Alternatively, the pulse-resistant INPUT 2 may be used in the frequency range up to 1 GHz. If INPUT 2 is switched on, the user can choose between AC and DC coupling.



The *RF INPUT 50 OHM* softkey sets the input impedance to 50 Ohm (= default setting). All level indications are referenced to 50 Ohm.

IEC/IEEE-bus command `:INPut<1|2>:IMPedance 50`

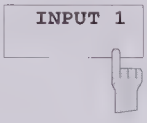


The *RF INPUT 75 OHM/RAM* softkey sets the input impedance of the ESI to 75 Ohm including the matching element RAM. All level indications are referenced to 75 Ohm.

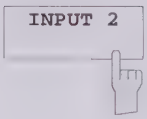
IEC/IEEE-bus command
`:INPut<1|2>:IMPedance:CORR RAM`

The *RF INPUT 75 OHM/RAZ* softkey sets the input impedance of the ESI to 75 Ohm including the matching element RAZ. All level indications are referenced to 75 Ohm.

IEC/IEEE-bus command
`:INPut<1|2>:IMPedance:CORR RAZ`



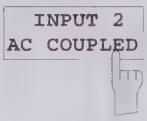
The *INPUT 1* softkey activates input 1 (default setting).

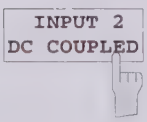


The *INPUT 2* softkey activates pulse-resistant input 2. If input 2 is used, the frequency range is restricted to 1 GHz. Higher frequencies cannot be set.

IEC/IEEE-bus command

`:INPut<1|2>:TYPE  INPUT1|INPUT2`





The *INPUT 2 AC COUPLED* and *INPUT 2 DC COUPLED* softkeys select AC or DC coupling for RF input 2. The default setting is AC coupling. The lower frequency limit is 1 kHz.

To indicate that input 2 with AC or DC coupling is activated, the enhancement label I2A or I2D is shown on the display.

If the ESI is operated with RF input 1, the softkeys are not available (enhancement label IN1).

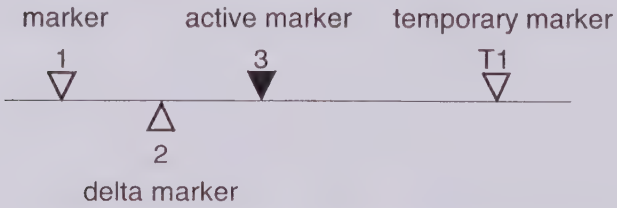
IEC/IEEE-bus command `:INPut<1|2>:COUPling AC | DC`

Marker Functions – *MARKER Key Group*

The markers are used for marking points on measurement curves (traces), reading out measurement values and for quickly selecting a screen mode. Preselected measurement routines can be called by pressing a key in the marker menu. The ESI has four markers and four delta markers per measurement window. The currently activated marker can be shifted with the cursor keys, the roll-key or the softkeys. The softkeys are defined according to the type of display representation selected (frequency or time domain).

The marker which can be moved by the user is defined as the **active marker**.

Examples of marker displays:



Temporary markers are used in addition to the markers and delta markers to evaluate the measurement results. They disappear when the associated function is deactivated.
The measurement values of the active marker (also called **marker values**) are displayed in the marker field. In the **marker info list**, the measurement values from all enabled markers are sorted in ascending order. The marker info list can be switched off with the *MARKER INFO* softkey so that only the values for the active marker are shown.

The summary markers have a special function. They read out the rms or average value of the current trace or the trace averaged over several sweeps in the marker info list. These markers are not displayed.

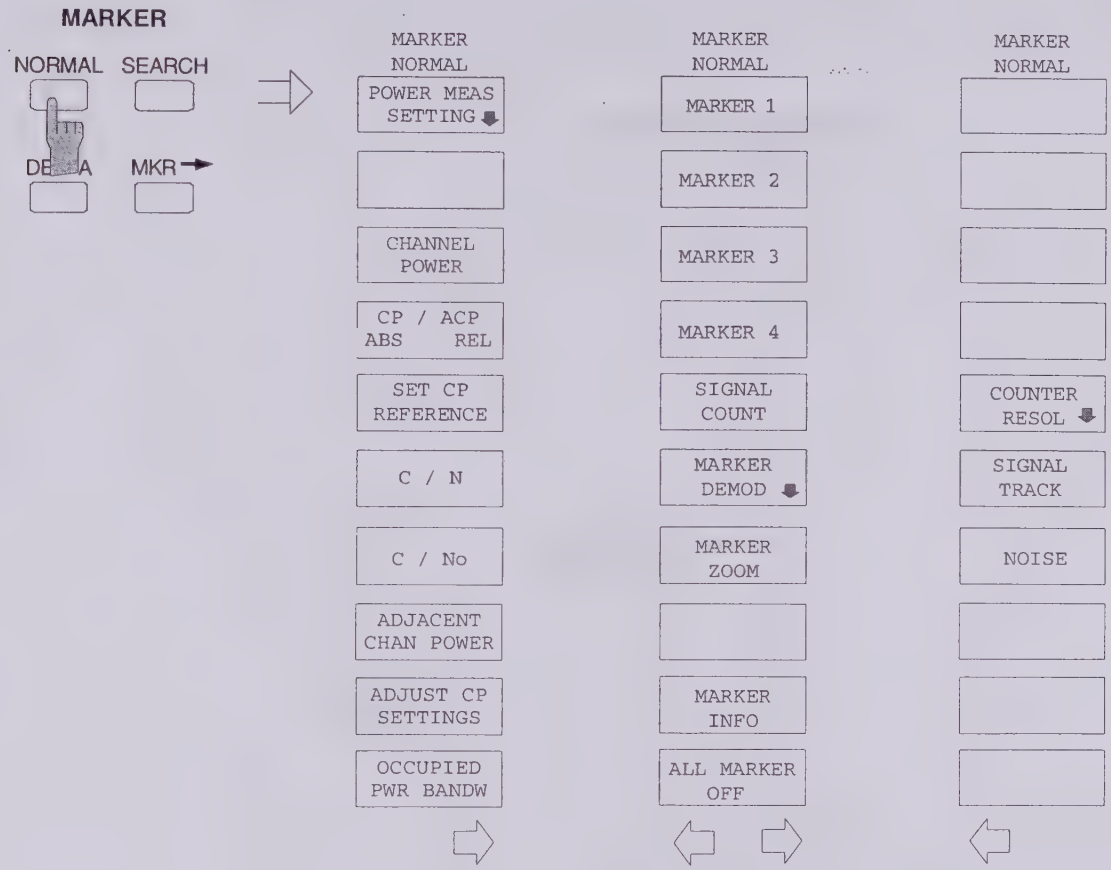
Main Markers– *NORMAL Key*

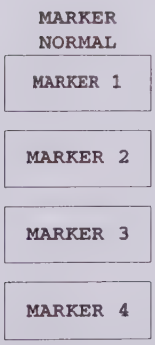
The *NORMAL* key calls a menu which contains all the standard marker functions. The current state of the markers is indicated by a colored illumination of the softkeys. If no marker is enabled prior to pressing the *NORMAL* key, *MARKER 1* will be enabled as the reference marker and a peak search on the trace is carried out (assumption: at least one trace is active). Otherwise, the peak search is omitted and the entry window for the reference marker is activated.

The marker field in the upper right corner of the display screen shows the marker values, in this case, the frequency, the level and the currently selected trace.

```
MARKER 1  [T1]
  -27.5 dBm
123.4567 MHz
```

MARKER NORMAL menu:

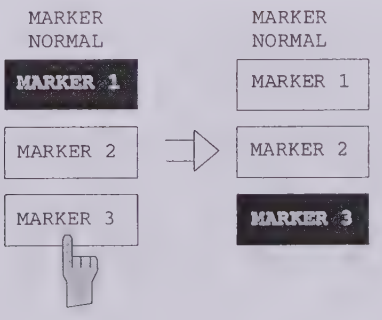




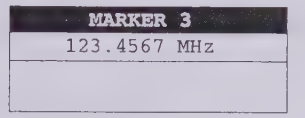
The *MARKER 1* to *MARKER 4* softkeys switch the corresponding marker on/off or activate it as the reference marker. If the marker is activated as a reference marker, an entry field for manually setting the position of the reference marker is opened simultaneously. If the marker is disabled, the softkey is not illuminated. Enabled markers and the reference marker are indicated by illuminating the corresponding softkeys in different colors.(In the instrument default state, the active reference marker is displayed in red and enabled markers are displayed in green.)

Operating example:

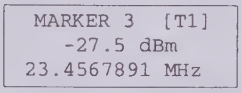
MARKER 1 is shown as the reference marker by the colored background illumination. *MARKER 2* through *MARKER 4* are turned off.

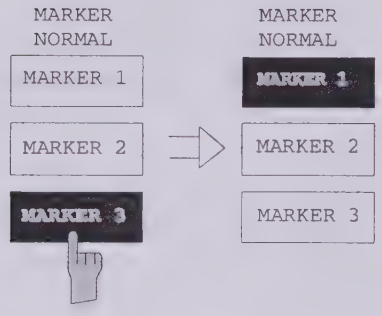


Pressing the *MARKER 3* softkey switches *MARKER 3* on and it becomes the reference maker. The previous reference marker remains enabled and the softkey remains illuminated. However, the entry mode for this marker is not now active. Instead, the entry window for *MARKER 3* is opened and the position of *MARKER 3* can be shifted.



The information in the marker field also changes to describe the new reference marker.





Pressing the current reference marker (*MARKER 3)* softkey again switches *MARKER 3* off. If at least one marker is enabled, the marker with the smallest number will be selected as the new reference marker (in the example, *MARKER 1*). Switching off the last active marker also deletes are delta markers.

IEC/IEEE-bus commands

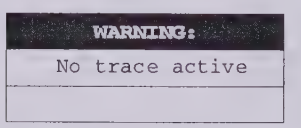
```
:CALCulate<1|2>:MARKer<1..4>[:STATe]  ON | OFF;
:CALCulate<1|2>:MARKer<1..4>:X  10.7MHz;
:CALCulate<1|2>:MARKer<1..4>:Y?
```

When several traces are displayed, the marker is set to the maximum value (peak) of the active trace with the lowest number (1 to 4). if a marker is already positioned there, it will be set to the frequency of the next highest level (next peak).

When the split screen mode is active, the marker will be placed in the active window (for *SCREEN A*: trace 1 or 3, for *SCREEN B*: trace 2 or 4). Since markers are attached to a trace, the marker can only be enabled when at least one trace is displayed in the corresponding window.

If a trace is turned off, the markers and marker functions attached to the trace are also switched off. If the trace is switched on again (*VIEW, CLR/WRITE*;..), these markers, along with any coupled functions will be restored to their original positions. A prerequisite for the restoration of the marker positions is that individual markers have not been used on another trace or that the sweep data (start/stop frequency for span > 0 or sweep time for span = 0) have not been changed.

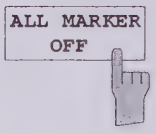
If a marker (or, delta marker) necessary for a marker function is not available, it will be automatically checked whether or not the enabling of the corresponding marker is possible (see above). If this is not the case, a warning is issued.



The activation of the desired marker function is then not possible.

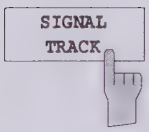
On the other hand, if the marker can be enabled, a peak search is automatically performed. Thereafter, the desired marker function can be executed.

MARKER NORMAL menu:



The *ALL MARKER OFF* softkey switches off all markers (reference and delta markers). Similarly, it switches off all functions and displays correlated with the markers/delta markers (signal count, signal track, marker zoom, N dB down, shape factor, marker list and marker info).

IEC/IEEE-bus command `:CALCulate<1|2>:MARKer<1...4>:AOFF`



After each sweep, the *SIGNAL TRACK* softkey starts a search for the maximum signal level on the screen (*PEAK SEARCH)* and then sets the center frequency to the frequency of this signal (*MARKER ->CENTER).*

If a threshold line is enabled, only signals above the threshold level are considered. If no signal is over the threshold, the center frequency remains constant until a signal is available which is over the threshold.

If no marker is switched to the active trace, the next unused marker is automatically activated and positioned by the peak search routine.

In order to reduce the search range, it is possible to apply the *SEARCH LIMIT ON/OFF* function (see section: "Search Functions"). If the center frequency is changed, the position of the frequency line relative to the center frequency remains the same, ie its absolute position is correspondingly changed.

The softkey is only available in the frequency domain (spectrum) display mode (span > 0.)

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:COUNt ON |OFF;
:CALCulate<1|2>:MARKer<1..4>:COUNt:FREQuency?
```

The *MARKER ZOOM* softkey expands the area around the active marker. With the zoom function, more details of the spectrum can be seen. The desired display range can be defined in an entry window.

The sweep is stopped at the reference marker. The frequency of the signal is counted and the measured frequency becomes the new center frequency. The zoomed display is set and the new settings are used by the ESI for further measurements.

As long as the switchover to the new frequency display range has not yet taken place, pressing the softkey will abort the procedure.

If no marker is activated when the softkey is pressed, then *MARKER 1* is automatically activated and set to the highest peak in the measurement window.

If an instrument setting is changed after selection of *MARKER ZOOM*, the function is aborted.

The *MARKER ZOOM* softkey is only available for frequency domain measurements (span ■ 0).

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:ZOOM  1KHZ
```

The *MARKER INFO* softkey opens the display of several markers within the grid. In the upper right corner of the grid, a maximum of 4 markers/delta markers with the marker symbols ■/■, marker number (1 to 4), position and measurement value are listed. For the output of the marker position, the number or displayed characters will be limited as required.

If the number of lines available is not enough for all the enabled markers and delta markers, first the markers and then the delta markers are entered into the info list

In the *SPLIT SCREEN* display, the info list is partitioned into 2 partial lists and assigned to the corresponding measurement window (*SCREEN A* and *SCREEN B*). The info list for *SCREEN A* contains the markers which are assigned to trace 1 or trace 3. The info list for *SCREEN B* contains the markers which are assigned to trace 2 and trace 4.

For the two measurement windows, it is not possible to turn the *MARKER INFO* function selectively on/off .

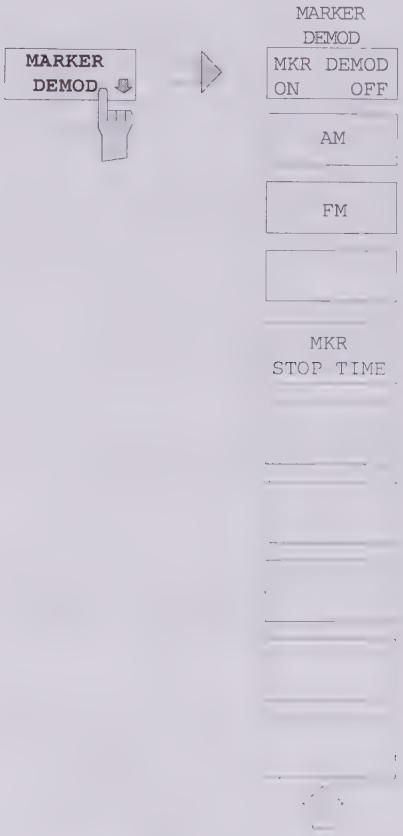
IEC/IEEE-bus command `:DISPlay:WINDow<1|2>:MINFo ON | OFF`

LF Demodulation

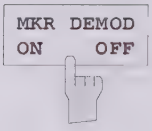
The ESI provides demodulators for AM and FM signals. With these demodulators, a displayed signal can be identified acoustically with of the internal loudspeaker or with external headphones. The frequency at which demodulation is activated is coupled to the markers. The sweep stops at the frequency determined by the set marker for the selected time and the RF signal is demodulated.

During time domain measurements (span = 0) the demodulation is switched on continuously.

MARKER NORMAL-MARKER DEMOD submenu:



The *MARKER DEMOD* softkey calls a sub-menu in which the type of demodulation desired, the duration of the demodulation may be selected



The *MKR DEMOD ON/OFF* softkey switches the demodulation on/off. When the demodulation is on, the sweep is stopped at all marker frequencies, assuming the signal is over the threshold, and the signal is demodulated until the entered sweep stop time elapses. A total of four stopping points (four markers) can be programmed.

If no marker is set when the demodulation is switched on, the ESI switches the first marker on (*MARKER 1*) and positions it on the trace peak.

IEC-Bus-Befehl

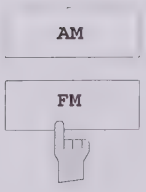
```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:DEM ON|OFF
```

The *MKR STOP TIME* softkey activates the entry window for setting the stop time.

The ESI stops the sweep at the marker or the marker for the duration of the defined stop time and then switches the demodulation on (see also *MKR DEMOD ON/OFF*).

IEC-Bus-Befehl

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:DEM:HOLDoff 3s
```



The *AM* and *FM* are selection switches of which only one can be activated at any one time. They are used to set the desired demodulation type, FM or AM. The default setting is AM.

IEC-Bus-Befehl

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:DEM:SELect  AM|FM
```

Frequency Measurement

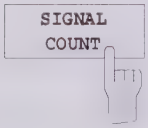
To accurately determine the frequency of a signal, the ESI is equipped with an internal frequency counter. The frequency counter measures the frequency of the RF signal at the intermediate frequency. Using the value found at the intermediate frequency, the ESI calculates the frequency of the RF signal by applying the known frequency conversion relationships.

The frequency measurement error depends only upon the accuracy of the frequency standard used (external or internal reference). Although the ESI always performs the frequency sweep in sync - no matter what frequency range is set - the frequency counter gives a more exact frequency measurement than a measurement performed with a marker. This is explained by the following:

- The marker only gives the position of a pixel on the trace and the frequency of the signal is deduced from this. The trace, however, contains only a limited number of pixels, so each pixel may represent a number of measurement values that depends on the selected span. This reduces the frequency resolution.
- The resolution with which the frequency can be measured is proportional to the measurement time. For measurement time reasons, the bandwidth is normally held as wide as possible and the sweep time is set a short as possible. This results in a loss of frequency resolution.

For the measurement with the frequency counter, the sweep is stopped at the reference marker, the frequency is measured to the desired resolution and then the sweep is allowed to continue (see also Chapter 2, "Measurement Examples").

MARKER NORMAL menu:



The *SIGNAL COUNT* softkey switches the frequency counter on/off.

The frequency is counted at the position of the reference marker. The sweep stops at the reference marker until the frequency counter outputs a result. The time required for a frequency measurement depends on the selected frequency resolution. The resolution is set in the *COUNTER RESOL* sub-menu.

If no marker is enabled when the *SIGNAL COUNT* softkey is pressed, *MARKER 1* is switched on and set to the trace peak.

The *SIGNAL COUNT* function is also indicated by [T x CNT] in the marker field on the display screen.

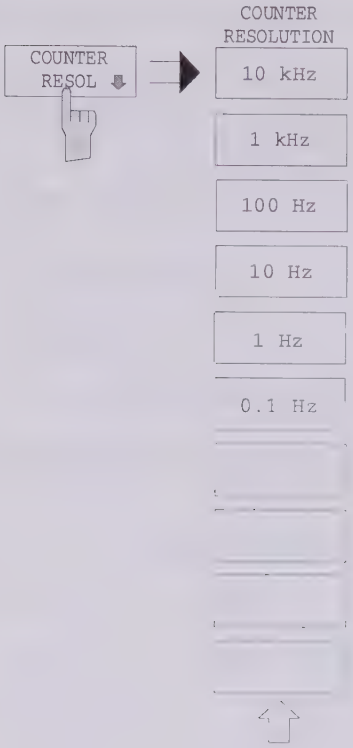
```
MARKER 2 [T1 CNT]
   -27.5 dBm
 23.4567891 MHz
```

Switching the *SIGNAL COUNT* function off is accomplished by pressing the softkey once again.

Note: *For digital resolution filters (RBW < 1kHz or softkey RBW 1kHz set to DIG), a analog prefilter of 2 kHz is active.*

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:COUNt  ON | OFF;
:CALCulate<1|2>:MARKer<1..4>:COUNt:FREQuency?
```



The *COUNTER RESOL* softkey in the right side menu opens a sub-menu in which the resolution of the frequency counter can be defined.
The value can be selected between 0.1 Hz and 10 kHz.

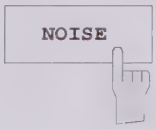
The time which the frequency counter requires for a measurement is proportional to the selected resolution. For example, a 1 Hz resolution will require approximately one second measurement time. In order to prevent slowing the sweep time unnecessarily, it is recommended that the frequency resolution be set as low as possible.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:COUNt:RES 1KHZ
```

Noise Power Density Measurement

MARKER NORMAL menu (right side menu):



The *NOISE* softkey switches noise measurement on/off.

During a noise measurement, the noise power density is measured at the position of the reference marker. The noise power density is displayed in the marker field dependent upon the vertical units in dBx/Hz (for logarithmic scale) or in V/Hz, A/Hz or W/Hz for linear scales. The correction factors for the selected bandwidth and the conversion of the IF logarithmic converter are automatically taken into consideration.

For trace setting AUTO SELECT, the sample detector is automatically switched on and off with the noise marker to provide for displayof the rms value of the noise power. For single sweep, a new sweep has to be started after the marker has been switched on in order to ensure that the trace is recorded with the correct detector.
For all other detector settings, the user is prompted to select the sample detector for optimum results as soon as the noise marker is switched on. In this case the sample detector has to be switched on manually.

In order to produce a smoother noise display, neighboring points (symmetrical to measurement frequency) on the trace are averaged.

In the time domain display, an average of the measurement values takes place in time (after each sweep).

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NOISe ON | OFF;
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NOISe:RESult?
```

Channel Power Measurements

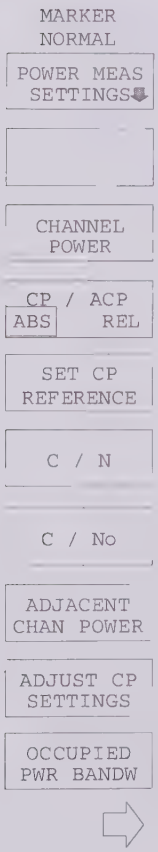
A modulated carrier is almost always used (exception e.g.,.: SSB-AM) for high-frequency transmission of information. Due to the information modulated onto the carrier, the latter covers a spectrum which is defined by the modulation, the data transmission rate and the signal filtering. Within a transmission band, each carrier is assigned a channel taking into account these parameters. In order to ensure error-free transmission, each transmitter must keep within its specified parameters. These include among others:

- the output power,
- the occupied bandwidth, i.e., the bandwidth within which a defined percentage of the power must be contained and
- the power received by adjacent channels.

Using the power measurement function, the ESI is capable of measuring all the specified parameters with high precision and at high speed.

The power measurements settings are performed in the left-hand side-menu *MARKER NORMAL*.

MARKER NORMAL menu:



The following measurements can be made:

- channel power (*CHANNEL POWER*)
- signal / noise power (*C/N*)
- signal / noise power density (*C/No*)
- adjacent channel power (*ADJACENT CHAN POWER*)
- occupied bandwidth (*OCCUPIED PWR BANDWIDTH*)

The channel power and the adjacent channel power can be measured either relative (*CP/ACP REL*) to the power in the utilised channel or in absolute terms (*CP/ACP ABS*).

Channel configuration is via sub menu *POWER MEAS SETTINGS*.

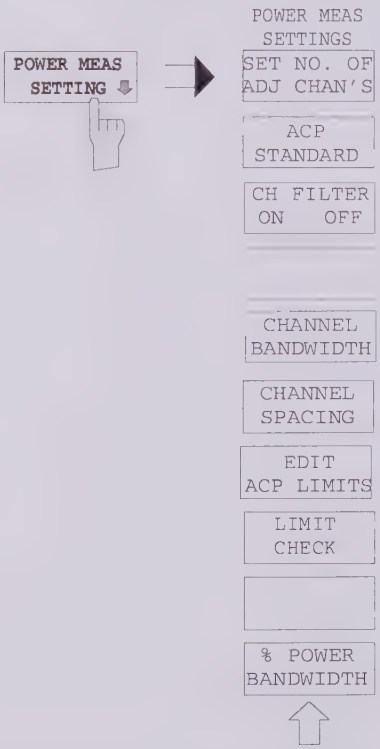
The above mentioned power measurements can be performed alternately.

Channel Configuration

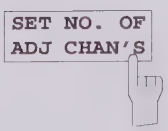
For all power measurements, a specified channel configuration is assumed which is, e.g. oriented on a specific radio communications system.
The channel configuration is defined by the nominal channel frequency (= center frequency of the ESI), the channel bandwidth (*CHANNEL BANDWIDTH*) and the channel spacing (*CHANNEL SPACING*).
The channel is indicated on the display screen by vertical lines located at a half-channel bandwidth to the left and to the right of the channel frequency. For the adjacent channel power measurement, the adjacent channels are also indicated by vertical lines. The lines of the utilised channel are labelled with CO for easier recognition.
Depending on the radio communication service, the power of the 1st alternate channel and/or 2nd alternate channel can be measured in addition (softkey *SET NO.OF ADJ CHAN'S*).

With the *ACP STANDARD* softkey, the channel configuration can be set automatically according to the regulations of different digital mobile-radio standards. For some standards, the channel power has to be evaluated by means of a root-cosine filter corresponding to the transmit filter. This filter is switched on automatically if the corresponding standards are selected but can be switched off manually (softkey *CH FILTER ON/OFF).*

MARKER NORMAL - POWER MEAS SETTINGS submenu:



The *POWER MEAS SETTINGS* softkey calls the sub-menu for the definition of the channel configuration.

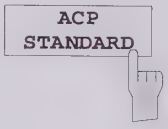


The *SET NO. OF ADJ CHAN'S* softkey activates the input of number ■n adjacent channels to be considered for adjacent channel power measurement
The individual powers are indicated separately. Example n=3:

```
CH0 Pwr   -20.00 dBm
ACP UP    -45.23 dBm
ACP LOW   -52.11 dBm
ALT1 UP   -60.04 dBm
ALT1 LOW  -61.00 dBm
ALT2 UP   -63.34 dBm
ALT2 LOW  -64.00 dBm
```

1, 2 or 3 adjacent channels are possible. ALT1 and ALT2 (Alternate Channel Power) indicate the channel power at ■ 2 ■ channel spacing and ■ 3 ■ channel spacing from the center of the channel.

IEC/IEEE-bus command : `[SENSe<1|2>:]POWer:ACHannel:ACPairs 2`



The *ACP STANDARD* softkey activates the selection of a digital mobile-radio standard. The parameters for the adjacent channel power measurement are set according to the regulations of the selected standard.

ACP STANDARD
NONE
NADC
TETRA
PDC
PHS
CDPD
CDMA800 FWD
CDMA800 REV
CDMA1900 FWD
CDMA1900 REV
W-CDMA FWD
W-CDMA REV
W-CDMA 3GPP FWD
W-CDMA 3GPP REV
CDMA2000 MC
CDMA2000 DS
CDMA ONE 800 FWD
CDMA ONE 800 REV
CDMA ONE 1900 FWD
CDMA ONE 1900 REV

The following standards can be selected:

NADC (IS-54 B)
TETRA
PDC (RCR STD-27)
PHS (RCR STD-28)
CDPD
CDMA800FWD
CDMA800REV
CDMA1900REV
CDMA1900FWD
W-CDMA FWD
W-CDMA REV
W-CDMA 3GPP FWD
W-CDMA 3GPP REV
CDMA2000 Multi Carrier
CDMA2000 Direct Sequence
CDMA ONE 800 FWD
CDMA ONE 800 REV
CDMA ONE 1900 REV
CDMA ONE 1900 FWD

If the full dynamic range of the analyzer is to be utilized for the W-CDMA measurement (for a power measurement in this standard), the RF attenuation has to be set to 0 dB.
However this is not done automatically to avoid damaging the analyzer input. Instead, a window displaying the following note is shown if one of the W-CDMA standards is selected: 'Attention: For higher dynamic range use *RF ATTEN MANUAL*=0dB.

The following parameters change according to the standard selected:

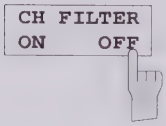
- channel spacing
- channel bandwidth
- modulation filter
- resolution bandwidth
- video bandwidth
- detector

Trace Maths and Trace Averaging are switched off.
The reference level is not changed when a standard is selected. It has to be set for an optimum dynamic range so that the signal maximum is in the vicinity of the reference level.

The basic setting *ACP STANDARD NONE*.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POWer:PRESet
NONE |NADC |TETRA |PDC |PHS |CDPD |F8CDma |R8CDma
|F19Cdma |R19Cdma |FWCDma | RWCDma |FW3Gppcdma
|RW3Gppcdma |M2CDma |D2CDma |FO8Cdma |RO8Cdma |FO19cdma
|RO19cdma
```



The *CH FILTER ON/OFF* softkey switches a modulation filter for the channel power and adjacent channel power measurement on or off.

When selecting the digital mobile-radio standards NADC and TETRA using the *ADC STANDARD* softkey, the softkey is automatically set to ON. When the other standards are selected, weighting is not selectable and the softkey is not available.

CH FILTER ON — The channel bandwidth is defined by the filter weighting alone. Therefore, the *CHANNEL BANDWIDTH* softkey cannot be operated.

The activated modulation filter influences the channel and adjacent channel power measurement.

Within the definition range of the filter, the individual pixels are weighted with the calculated filter attenuation as a function of the spacing to the channel center. The weighted display points are then added to the total channel power.

CH FILTER OFF — No modulation filter is switched on.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:POWer:CFIL ON|OFF
```

The *CHANNEL BANDWIDTH* softkey opens an entry window for setting the channel bandwidth for the transmission channel and the corresponding adjacent channels.

For all channels, the default setting is 14 kHz.

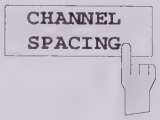
ACP CHANNEL BW

CHAN	BANDWIDTH
CH	14 kHz
ADJ	14 kHz
ALT1	14 kHz
ALT2	14 kHz

Note: *If the bandwidth of one channel is changed, the new value is also assigned to all subsequent channels in the table. The bandwidths for the individual channels can be set independently, however, by overwriting the table from the top to the bottom.*

IEC/IEEE-bus commands

```
:[SENSe<1|2>:]POWer:ACHannel:BWIDth[:CHANnel] 24KHZ
:[SENSe<1|2>:]POWer:ACHannel:BWIDth:ACHannel 24KHZ
:[SENSe<1|2>:]POWer:ACHannel:BWIDth:ALTernate<1|2> 24KHZ
```



The *CHANNEL SPACING* softkey opens an table for defining the channel spacing. The channel spacing is the spacing of the center frequency of a given channel relative to the center of the transmission channel.

The default setting for channel spacing is 20 kHz.

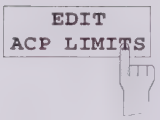
CHANNEL SPACING

CHAN	SPACING
ADJ	20 kHz
ALT1	40 kHz
ALT2	60 kHz

Note: *Channel spacings can be selected separately for each channel. If a spacing value is changed in the table, the following values are changed automatically.*

IEC/IEEE-bus commands

```
:[SENSe<1|2>:]POWer:ACHannel:SPACing[:UPPer] 24KHZ
:[SENSe<1|2>:]POWer:ACHannel:SPACing:ACHannel 24KHZ
:[SENSe<1|2>:]POWer:ACHannel:SPACing:ALT<1|2> 24KHZ
```



The *EDIT ACP LIMITS* opens a table for defining the limits for ACP-measurement.

ACP LIMITS

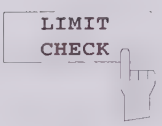
CHAN	CHECK	LOWER CHANNEL LIMIT	UPPER CHANNEL LIMIT
ADJ	√	-50 dB	-50 dB
ALT1	√	-60 dB	-60 dB
ALT2			

The limit values are defined either in units of dB (for*CP/ACP REL*) or in dBm (for *CP/ACP ABS*).

Note: *Measured values that exceed one of the limits are marked with an preceding asterisk.*

IEC/IEEE-bus commands

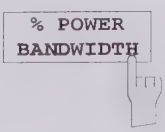
```
:CALCulate<1|2>:LIMit<1..8>:ACP:ACHannel 30DB, 30DB
:CALCulate<1|2>:LIMit<1..8>:ACP:ACHannel:STATe ON|OFF
:CALCulate<1|2>:LIMit<1..8>:ACP:ALT<1|2> 30DB, 30DB
:CALCulate<1|2>:LIMit<1..8>:ACP:ALT<1|2>:STATe ON|OFF
```



The *LIMIT CHECK* softkey switches on or off the limit check of the ACp measurement.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit:ACPower[:STATe] ON | OFF
:CALCulate<1|2>:LIMit<1..8>:ACP:ACHannel:RESult?
:CALCulate<1|2>:LIMit<1..8>:ACP:ALTernate<1|2>:RESult?
```



The *% POWER BANDWIDTH* softkey opens an entry window for defining the percentage of the power with respect to the total power in the displayed frequency range. This defines the occupied bandwidth (percent of the total power).

The permitted range is 10 % - 99,9 %

IEC/IEEE-bus command `:[SENSe<1|2>:]POWer:BANDwidth 99PCT`

Channel Power Measurement

The *CHANNEL POWER* measurement is performed by an integration of the measurement points within the channel bandwidth. The channel is marked by two vertical lines to the left and to the right of the center frequency as defined by the channel bandwidth (see Fig. 4-9).

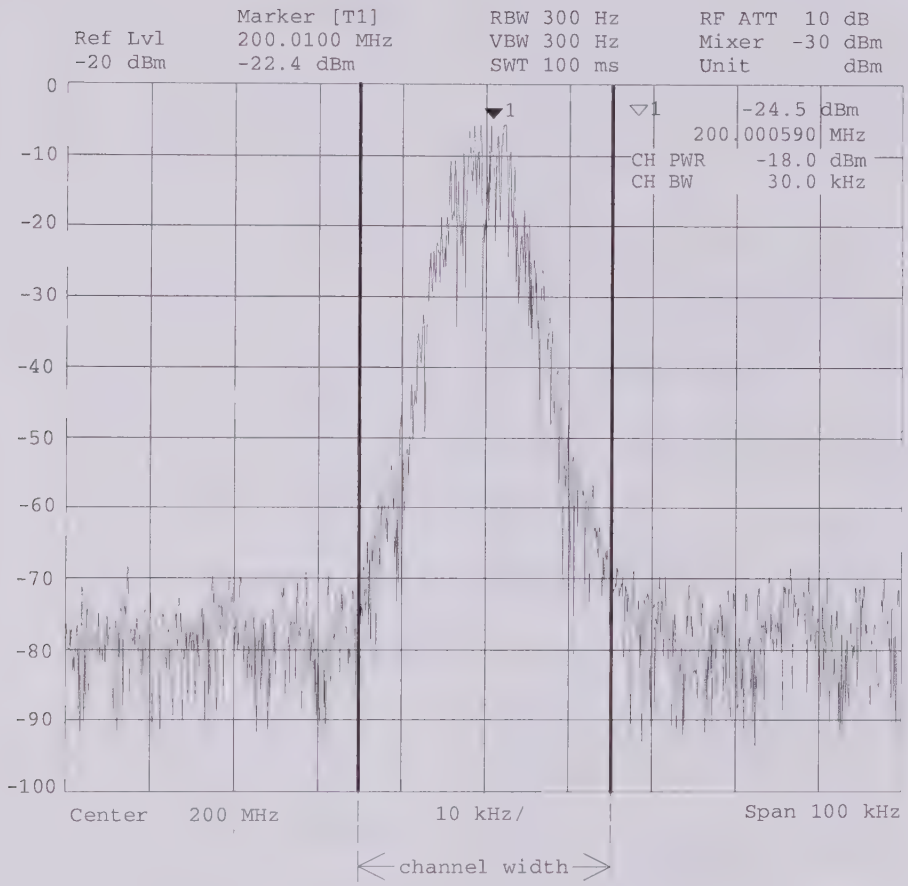


Fig. 4-9 Determination of the channel width

MARKER NORMAL menu:

CHANNEL POWER

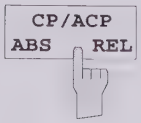
The *CHANNEL POWER* softkey initiates the calculation of the power in the measurement channel. The display takes place in the units of the y axis, e.g., in dBm, dBµV.

The calculation is performed by summing the power at the pixels within the specified channel.

The measurement is either absolute or relative to a reference power (see the *CP/ACP ABS/ REL* softkey).

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:FUNC:POW:SELect CPOWer;
:CALCulate<1|2>:MARKer<1..4>:FUNC:POW:RESult? CPOWer;
:CALCulate<1|2>:MARKer<1..4>:FUNC:POW[:STATe] OFF
```



The *CP/ACP ABS/REL* softkey (Channel Power/Adjacent Channel Power Absolute /Relative) switches between an absolute and relative display of the power measured in the channel or adjacent channel.

Channel power measurement

CP ABS — The absolute value of the power is displayed in the unit of the Y axis, eg in dBm, dBV.

CP REL — The power of a freely selected channel is measured. This power is set in relation to the power of a reference channel. The reference channel power is selected beforehand using the *SET CP REFERENCE* softkey, ie:

1. Declare the power in the currently measured channel as the reference value using the *SET CP REFERENCE* softkey.
2. Set the channel of interest by changing the channel frequency (ESI center frequency).

In case of linear scale of the Y axis the relative power (CP/CP_{ref}) of the new channel is displayed in addition to the reference channel. In case of dB scale, the logarithmic ratio $20 \cdot \log (CP/CP_{ref})$ is displayed.

Therefore, the relative channel power measurement can also be used for universal adjacent channel power measurements.

Example:
Measurement of the 1597-QCDMA adjacent channel power. The useful channel and the adjacent channels have different bandwidths (1.23 MHz or 30 kHz).

Adjacent channel power measurement

The power of the adjacent channels is measured. The reference value is the power of the useful channels (see measurement of the adjacent channel power). The useful channel is marked by two vertical lines that are labelled with C0.

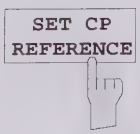
ACP ABS — The powers of the useful channel and of the adjacent channels are displayed as absolute values in the unit of the Y axis.

ACP REL — The logarithmic ratio $20 \cdot \log (CP/CP_0)$ of the powers of the adjacent channels to the useful channel is displayed

The softkey is not available for *OCCUPIED PWR BANDWIDTH*, *C/N* and *C/N0*

IEC/IEEE-bus command

```
:[SENSe<1|2>:]POWer:ACHannel:MODE ABS|REL
```



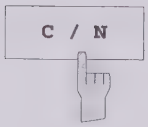
The *SET CP REFERENCE* softkey sets the reference value to the currently measured channel power for an activated *CHANNEL POWER* power measurement,.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]POWer:ACHannel:REF:AUTO ONCE
```

Signal / Noise Power Measurement

MARKER NORMAL menu:

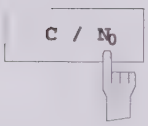


The *C/N* (Carrier to Noise) softkey calculates the ratio of carrier power to noise power and the power of interference signals in the channel defined under *POWER MEAS SETTING*. For the measurement, a marker must be set to the carrier of interest.

The unit of C/N is dB when the display is logarithmic. When the display is linear, C/N is shown without a unit.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:SELect CN;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:RESult? CN;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW[:STATe] OFF
```



The C/N_0 softkey starts the C/N_0 measurement.
In contrast to the *C/N* measurement, *C/N* calculates the ratio of carrier power to noise and interference signals based on a 1 Hz bandwidth in the channel defined under *POWER MEAS SETTING*.

The unit of C/No is dB/Hz when the display is logarithmic and 1/Hz when the display is linear.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:SELect CN0;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:RESult? CN0;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW[:STATe] OFF
```

Measurement procedure:

1. Activate a marker and position it to the peak of the carrier signal (e.g., with the *Marker -> Peak* softkey).
2. Select With the desired frequency range (channel) with the *FREQUENCY CENTER* and *CHANNEL BANDWIDTH* (*POWER MEAS SETTING* sub-menu) softkeys.
3. Press the *C/N* or C/N_0 softkey. The marker is set to reference fixed and activates each measurement. It must be observed that the carrier is either located outside of the measurement channel or turned off at the UUT (Unit Under Test).
4. Press the ADJUST CP SETTINGS softkey to active the default settings with modified channel parameters.

The measurement values for C/N or C/N_0 are displayed in the marker info field.

Notes: – *If no carrier marker was set, only N or N_0 with the appropriate units is displayed.*
– *Is the carrier located inside the measurement channel, C/C+N or $C/C+N_0$ will be displayed*

Example:

The signal-to-noise ratio of the carrier (f = 199.9 MHz) in the channel with +100 kHz separation from 200 MHz (channel center frequency) is to be measured. The channel bandwidth is 150 kHz.

1. Using the *CENTER* key, set the center frequency to the channel center frequency 200 MHz.
2. Using the *SPAN* key, set the span, e.g., to 1 MHz (carrier must be visible).
3. Using the *MARKER NORMAL* key, activate *MARKER 1* (If Marker 1 was not yet active, the function *MARKER PEAK* is automatically executed. In this case, skip step 4.)
4. Using the *MARKER PEAK* key, set *MARKER 1* on the carrier (assumption: the 200 MHz carrier has the highest level in the selected span).
5. Press the *MARKER NORMAL* key and change to the left-hand supplementary menu.
6. Using the *POWER MEAS SETTING* softkey, call the sub-menu for defining the measurement channel.
7. Using the *CHANNEL BANDWIDTH*: softkey, set the bandwidth to 150 kHz (The channel spacing does not need to be entered for this measurement). Then press ▮ menu change key.
8. Using the *C/N* softkey, start the C/N measurement. In the marker info field, the outputs *CHANNEL CENTER, CHANNEL BANDWIDTH* as well as the corresponding C/N measurement values appear. *MARKER 1* is also set to reference fixed.
9. Using the *ADJUST CP SETTINGS* softkey, activate the default settings with modified channel parameters (channel bandwidth = 150kHz) for the correct C/N measurement (span = 2 × channel bandwidth = 300 kHz, RBW = 3 kHz, VBW = 10 kHz, detector: sampling).

Two vertical lines mark the channel 200 MHz ± 75 kHz in which the noise measurement is performed (see Fig.4-10). The reference value is the measurement from *MARKER 1* (Reference Fixed).

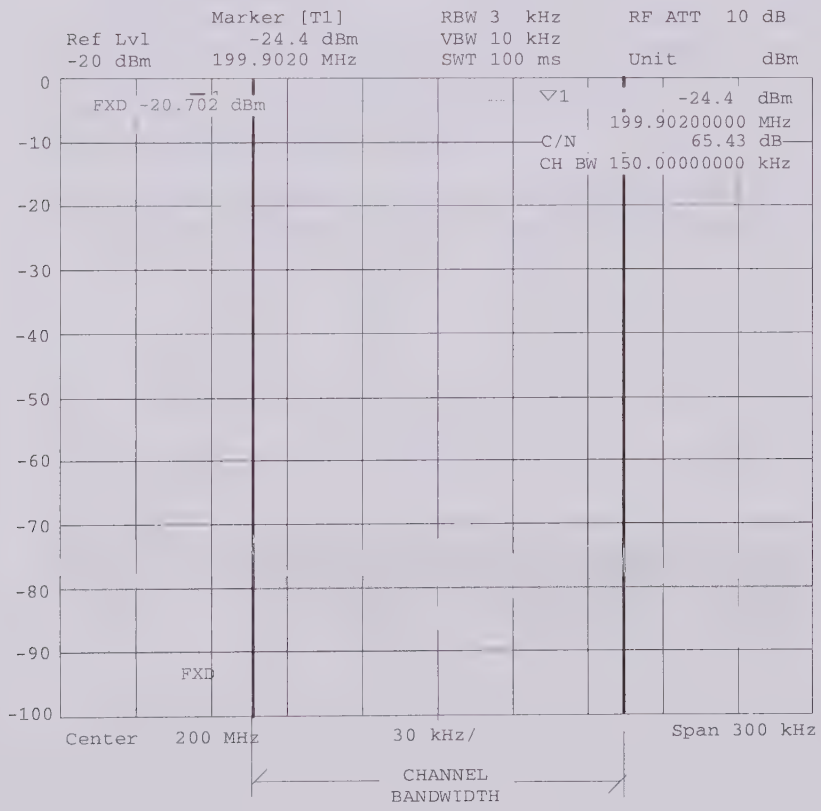
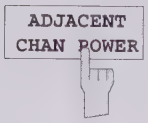


Fig.4-10 Example: measurement of the signal/noise power

Adjacent Channel Power

MARKER NORMAL menu:



The *ADJACENT CHAN POWER* softkey starts the measurement of the adjacent channel power.

The *ADJACENT CHAN POWER* measures the power which the transmitter delivers to the two adjacent channels (upper channel , lower channel). The measurement values are displayed according to the setting of the *CH/ACD ABS/REL* softkey as absolute values in the scale of the X axis (see Fig.4-11) or as a logarithmic ratio of adjacent channel to useful channel in dB (20 ■ log (CP/CP_0).

If the power of the other neighbouring channels is to be measured in addition to the adjacent channel power, the number of adjacent channels can be extended (on one side only) using *SET NO. OF ADJ CHAN'S* in the submenu *POWER MEAS SETTINGS*.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:SELect ACP;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:RESult? ACP;
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW[:STATe] OFF
```

A prerequisite for the correct measurement of the adjacent channel power is the correct setting of the ESI center frequency, the channel bandwidth and the channel spacing. The *CHANNEL SPACING* and C*HANNEL BANDWIDTH* are defined in the *POWER MEAS SETTINGS* sub-menu.

For an activated measurement of adjacent channel power, the analyzer itself optimally sets all other values (span, resolution bandwidth, detector, etc.) after the *ADJUST CP SETTINGS* softkey is pressed. The carrier power in the utilised channel, the power (absolute or relative to the utilised channel) in the upper and lower adjacent channels as well as the largest of the two power values and the channel raster with channel spacing and bandwidth are displayed as the result of the measurement. The C0 lines mark the bandwidth of the carrier channel. Other unlabelled frequency lines mark the adjacent channels (see Fig.4-11). With *SET NO. OF ADJ CHAN'S 2* selected, the other two neighbouring channels (1st Alternate Channels) are displayed as well, with *SET NO. OF ADJ CHAN'S 3* selected, an additional channel each (2nd Alternate Channels).

The measurement values are updated and displayed until the *ADJACENT CHAN POWER* softkey is pressed again and the measurement of the adjacent channel power is stopped.

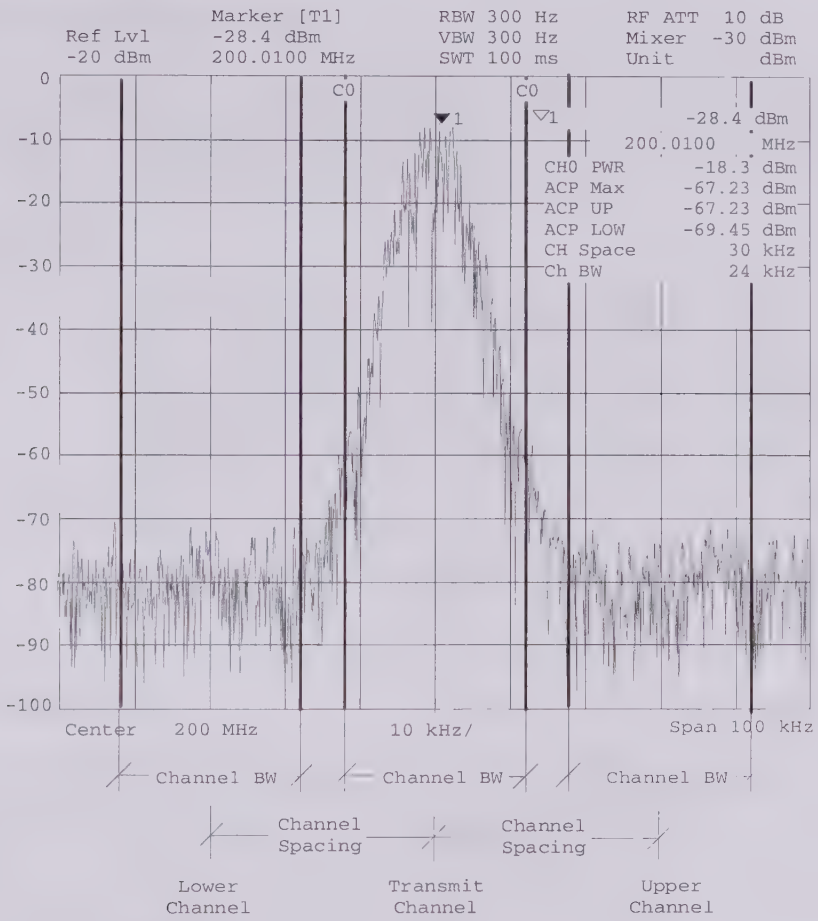


Fig.4-11 Measurement of the adjacent channel power.

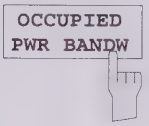
If the limit check is activated for ACP measurements, the result of the limit check (PASSED/FAILED) is displayed as well as an asterisk preceding each measured ACP power that exceeded one of the limits.

Note: *The limit check is activated and the limits are defined in the POWER MEAS SETTINGS menu.*

Occupied Bandwidth Measurement

An important characteristic of a modulated signal is the bandwidth which it occupies. In a radio communications system, for instance, the occupied bandwidth must be limited prevent in adjacent channel interferences. The occupied bandwidth is defined as the bandwidth in which a defined percentage of the total transmitter power is contained. The percentage of the power can be set between 10 and 99% in the ESI.

MARKER NORMAL menu:



The *OCCUPIED PWR BANDW* (occupied power bandwidth) softkey starts the measurement for determining the occupied bandwidth.
In the spectrum display mode, the bandwidth is determined in which a predefined percentage of the power in the displayed bandwidth is contained. (selectable in the *POWER MEAS SETTINGS* sub-menu with the : *% POWER BANDWIDTH* softkey). The occupied bandwidth is output to the marker display field and marked on the trace with temporary markers.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:SELect OBW
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW:RESult? OBW
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:POW[:STATe] OFF
```

Measurement principle:

For example, the bandwidth is to be found in which 99% of the signal power is contained. The routine calculates first the total power of all displayed points (pixels) of the trace. In the next step, the measurement points from the right edge of the trace are integrated until 0.5% of the total power is reached. Then the ESI integrates, in an analog fashion, from the left edge of the trace until 0.5% of the power is reached. The delta marker is positioned at this point. Thus, 99% of the power is located between the two markers. The difference between the two frequency markers is the occupied bandwidth which is displayed in the marker info field.

A prerequisite for the correct operation of the measurement is that **only** the signal to be measured is visible on the display screen of the ESI. An additional signal would falsify the measurement.

In order to be able to perform correct power measurements, especially for noisy signals, and thus to achieve the correct occupied bandwidth, the selection of the following parameters should be observed:

RBW	<< occupied bandwidth (■ approx. 1/20 of the occupied bandwidth, for voice communications, typ. 300 Hz or 1 kHz)
VBW	■ 3 x RBW
detector	sampling
span	■ 2 to 3 x occupied bandwidth

According to the application or other measurement guidelines, it may be necessary or reasonable to average a definite number of sweeps in order to achieve a usable value for the occupied bandwidth.
This is provided by the *TRACE* (1....4) key group and the averaging function. With the *SWEEP COUNT* softkey, the number of averages is defined.
Some measurement instructions (e.g. PDC, RCR, STD-27B) require the occupied bandwidth to be measured by means of a peak detector. In this case, the detector of the ESI must be corrected appropriately.

Parameters for Channel Power Measurements / Configuration

For the correct measurement of channel power, C/N, C/N0, adjacent channel power and occupied bandwidth, it is recommended that an automatic optimisation of the analyzer settings be performed after enabling the corresponding measurement and selecting the channel configuration (channel power settings).

MARKER NORMAL menu:

The *ADJUST CP SETTINGS* softkey optimises automatically the settings of the analyzer for the selected power measurement (see below).

All relevant analyzer settings for a power measurement within a defined frequency range (channel bandwidth) are optimally set including:

- span
- resolution bandwidth
- video bandwidth
- detector

dependent upon the channel configuration (channel bandwidth and, if needed, channel spacing).

The trace mathematical functions and trace averaging are switched off.

The reference level is not influenced by the automatic optimisation routine. The reference level is to be so adjusted that the signal maximum is located near the reference level.

The optimisation is performed only once, however, if necessary, the instrument settings may be changed later.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]POWer:ACHannel:PRESet ADJust
```

Span

The span should cover at least the frequency range that is to be observed. For channel power measurements, C/N and C/N0, this is the channel bandwidth. For adjacent channel power measurements, this is the utilised channel bandwidth and the adjacent channels located within the channel spacing.
If the span is large compared to the observed frequency band(s), then only a few points on the trace are available for the measurement.

The *ADJUST CP SETTINGS* softkey sets the span as follows:

2 ■ channel bandwidth	for channel power, C/N, C/No or
2 ■ channel spacing + channel width	for adjacent channel power
4 ■ channel bandwidth	for adjacent channel power and NO. OF ADJ CHAN'S 2
6 ■ channel spacing + channel width	for adjacent channel power and NO. OF ADJ CHAN'S 3

For measurements of the occupied bandwidth, the span is not influenced.

Resolution bandwidth (RBW)

In order to achieve acceptable speed as well as the necessary selectivity (to suppress spectral components outside of the channel to be measured and, especially adjacent channels), the resolution bandwidth that is selected must not be too narrow or too broad.
If the resolution bandwidth is too narrow, the measurement speed becomes very slow and it is possible that relative spectral components are not displayed (due to the sampling detector necessary for power measurements and the finite number of points).
On the other hand, the resolution bandwidth should not be so broad that, due to insufficient selection, spectral components outside of the observed frequency range (from adjacent channel) falsify the measurement results.

The *ADJUST CP SETTINGS* softkey sets the resolution bandwidth (RBW) dependent upon the channel bandwidth as follows:

RBW ≤ 1/40 of the channel bandwidth. The maximum possible RBW, with due regard to the 1, 2, 3, 5 step size and the requirement RBW ≤ 1/40 will be selected.

The RBW is not influenced by measurements of the occupied bandwidth.

Video bandwidth (VBW)

Since a power measurement of the noise components is also necessary (otherwise, errors occur due to the logarithmic characteristics of the spectrum analyzer), the video bandwidth should be slected to be substantially larger than the resolution bandwidth.

The *ADJUST CP SETTINGS* softkey adjusts the video bandwidth (VBW) dependent upon the channel bandwidth as follows:

VBW ≤ 3* RBW. The minimum VWB with regard to the available 1, 2, 3, 5 step size is selected.

Grid scale

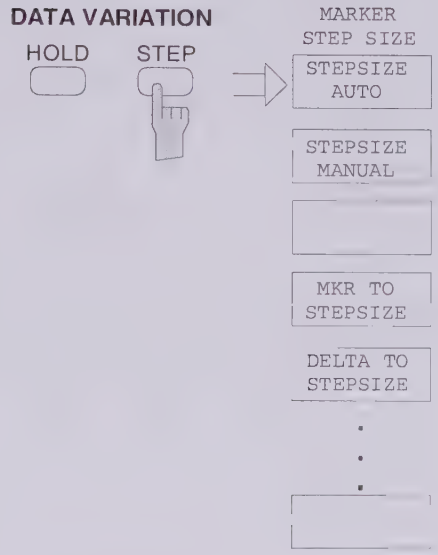
The *ADJUST CP SETTINGS* softkey sets the grid scale to the 100-dB range. Thereby, a wide dynamic range in channel power measurements is achieved.

Detector

The *ADJUST CP SETTINGS* softkey selects the sampling detector.
The sampling detector is to be selected, above all, for correct power measurements of noisy signals within the observed frequency range.

Marker Step Size

DATA VARIATION – STEP menu:



The *STEP* key in the *DATA VARIATION* key group opens a menu to match the marker step size to each individual application. In order to change the step size, the marker entry mode must already be active.

Control is returned to the *MARKER NORMAL* menu via the menu key.

The *STEPSIZE AUTO* softkey sets the marker step size to *AUTO*. In this case, the step size is exactly 10% of the grid. A one-raster movement of the roll-key corresponds to one pixel.

STEPSIZE AUTO is the default setting.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:STEP:AUTO  ON|OFF
```

The *STEPSIZE MANUAL* softkey activates the entry window for defining a fixed value for the marker step size.

Pressing the step key shifts the marker position by the selected step size. The resolution of the roll-key is always one pixel per raster.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:STEP 10KHZ
```

The *MKR TO STEPSIZE* softkey sets the marker step size to the current marker frequency or marker time.

In the frequency domain, this function is well suited to harmonic measurements. The marker is set to the largest signal using the peak search function. After activation of the *MKR TO STEPSIZE* function, the marker is set to the corresponding harmonic of the signal each time the cursor key or is pressed when entering the marker position (see also Chapter 2, "Measurement Examples").

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:MSTep
```

The *DELTA TO STEPSIZE* softkey sets the marker step size to the difference between the reference marker and the last active delta marker.

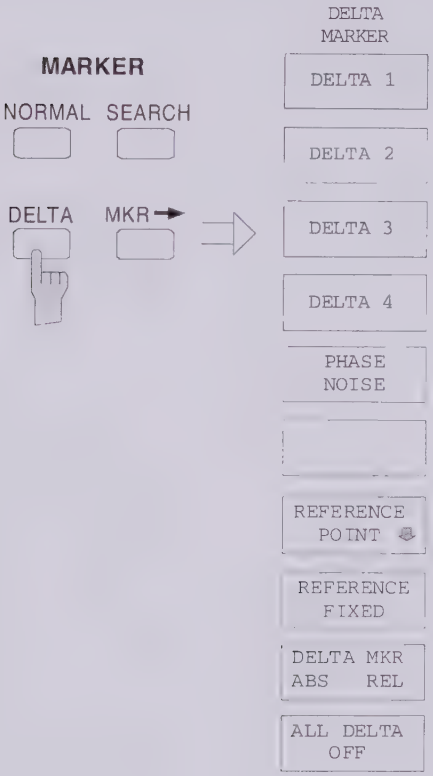
The softkey is only available when at least one delta marker is enabled.

IEC/IEEE-bus command --

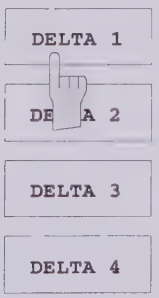
Delta Markers – *DELTA Key*

The delta marker.s are used to measure a level or frequency referred to a reference marker. They are always referenced to the marker whose position was last changed. A delta marker is displayed as an empty △ symbol. The reference marker is displayed as a filled ▼ symbol.

MARKER DELTA menu:



The *DELTA* key switches a delta marker on and calls the menu for its control. If no marker is enabled, *MARKER 1* is automatically activated when the delta marker is switched on. The delta marker activated to entry mode is shown on the display screen as a filled ▲ symbol.



The *DELTA 1 to 4* softkeys are used to enable delta markers 1...4. The control of the delta markers corresponds to that of the markers. After a delta marker has been enabled, all entries are now applicable to this marker. The main marker must be activated anew if its position is to be changed.

The delta marker field on the display screen contains the delta marker number, the difference frequency from the delta marker to reference marker and the level difference between the active delta markers and reference markers.

The indicated differences are, in general, referred to the reference marker. If the *PHASE NOISE* or *REFERENCE FIXED* functions are enabled, the reference values under *REFERENCE POINT* are applicable.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:DELTamarker<1..4>  ON|OFF
:CALCulate<1|2>:DELTamarker<1..4>:X 10.7MHZ
:CALCulate<1|2>:DELTamarker<1..4>:X:REL?
:CALCulate<1|2>:DELTamarker<1..4>:Y
```

The *DELTA ABS REL* softkey switches between relative and absolute entry modes for the delta-marker frequency.

In the *REL* position, the delta marker frequency is entered relative to the reference marker. In this case, the entry mode for the delta-marker frequencies is also relative.

In the *ABS* position, the entry of the delta-marker frequency is in terms of absolute frequency.

The default setting is *REL*.

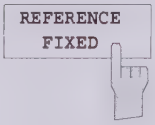
IEC/IEEE-bus command

```
:CALCulate<1|2>:DELTamarker<1..4>:MODE  ABS | REL
```

The *ALL DELTA OFF* softkey switches off all active delta markers and any associated functions (e.g. *REFERENCE FIXED*, *PHASE NOISE*).

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELTamarker<1...4>:AOFF
```



The *REFERENCE FIXED* softkey enables/disables relative measurements with respect to a fixed, measurement-curve-independent reference value.

The information in the delta-marker field on the display screen is referenced to this fixed reference value. For the generation of the marker lists using *MARKER INFO* list, the delta markers are also output relative to a fixed reference. In the lists, the *REFERENCE POINT* is tagged by the number of the reference marker (only one enabled)

When *REFERENCE FIXED* is enabled, the current settings of the reference marker become the reference values. If no marker is active, *MARKER 1* (with peak search) is activated. After transferring the reference values, all markers are deleted, and the active delta marker is set to the position of the reference value. Additional delta markers can be switched on.

The reference value can be subsequently changed

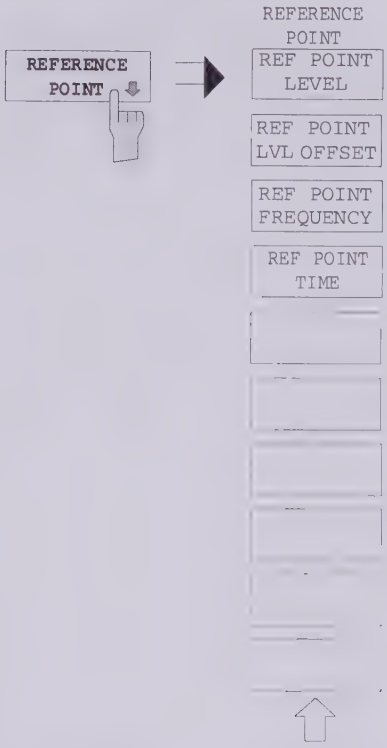
1. by shifting it in the *REFERENCE POINT* sub-menu.
2. by starting a search:
   In the *MARKER NORMAL* menu the *REF POINT* is handled as a reference marker (even though it is not bound to the trace). This means, that it will be shown as enabled and can also be changed in position. The co-ordinates of the *REF POINT* are overwritten by the marker values (they lie, by definition, on the trace). Thus, it is possible, even for an enabled *REFERENCE FIXED*, to define a new reference point function with search functions.

The *REFERENCE FIXED* function is particularly useful for measurements which are performed relative to a reference signal that is not available during the whole measurement time (e. g. harmonics measurements, see chapter "Measurement Example").

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELTamarker<1..4>:FUNCtion:FIXed ON|OFF
```

MARKER DELTA- REFERENCE POINT submenu:



The *REFERENCE POINT* softkey opens a sub-menu in which the reference value the *REFERENCE FIXED* and *PHASE NOISE* functions can be modified.

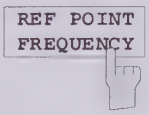
The position of the reference value is indicated by two additional display lines (horizontal and vertical). In addition, an offset level may be defined which is added to each difference during output.

The softkey is only available when the *REFERENCE FIXED* or *PHASE NOISE* function is switched on.

The *REF POINT LEVEL* softkey activates an entry box for setting the reference level relevant to the *REFERENCE FIXED* or *PHASE NOISE.* functions.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIXed:RPOint:Y -10DBM
```



The *REF POINT FREQUENCY* softkey activates the entry box for the input of a reference frequency for the *REFERENCE FIXED* or *PHASE NOISE.* functions.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIXed:RPOint:X 10.7MHZ
```

The *REF POINT LVL OFFSET* softkey activates the entry box for the entry of an additional offset level during output when the *REFERENCE FIXED* or *PHASE NOISE.* functions are enabled.

The offset level is set to 0 dB when the *REFERENCE FIXED* or *PHASE NOISE.* functions are switched on.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIX:RPO:Y:OFFSet 10DB
```

The *REF POINT TIME* softkey activates the entry box for the input of a reference time for the *REFERENCE FIXED* function in the time domain (span = 0).

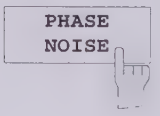
The entry of a reference time for the *PHASE NOISE* function is not possible.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELT<1..4>:FUNC:FIXed:RPOint:X 100ms
```

Phase Noise Measurement

MARKER DELTA menu:



The *PHASE NOISE* softkey switches the *PHASE NOISE* function on/off.

When *PHASE NOISE* measurement is switched on, the frequency and level of the reference marker are used as fixed reference values, i.e. the *REFERENCE FIXED* function is activated.

The difference between this reference point and the active delta markers is determined. The correction factors for bandwidth and the logarithmic converter are automatically taken into account. The sampling detector is automatically seleced to allow the effective noise power to be displayed. The measured values are displayed in the delta marker field in units of dBc/Hz.

If several delta markers are enabled, only the measurement value output of the active marker is shown in the marker field. Using *MARKER INFO* and *MARKER LIST* the measurement data of all delta markers can be displayed.

If no marker is present when the *PHASE NOISE* function is enabled, *MARKER* 1 is automatically switched on (peak search), and the marker values are saved as reference values. The reference value can be changed later in the *NORMAL* menu, *SEARCH* menu or *REFERENCE POINT* sub-menu (see *REFERENCE FIXED* softkey).

Turning on an additional marker causes the *PHASE NOISE* function to be disabled.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:DELTamarker<1..4>:FUNC:PNOise  ON | OFF
:CALCulate<1|2>:DELTamarker<1..4>:FUNC:PNOise:RESult?
```

Delta-Marker Step Size - *STEP Key*

STEP-DELTA STEP menu:

The *STEP* key in the *DATA VARIATION* key group opens a menu to match the step size of the individual delta markers to the specific application. In order to change the step size, the entry mode for a delta marker must already be active.

Control is returned to the DELTA MARKER menu via the menu key.

The *STEPSIZE AUTO* softkey sets the delta marker step size to *AUTO*. In this case, the step size of the delta marker is exactly 10% of the grid. The roll-key corresponds to 1/500, i.e., for each rotational pulse, the delta marker is shifted one pixel position.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELTamarker<1..4>:STEP:AUTO ON | OFF
```

The *STEPSIZE MANUAL* softkey permits the entry of a fixed value for the delta marker step size.

Pressing the step-key shifts the marker position by the selected step size. The roll-key resolution, however, always remains constant at 1 pixel.

IEC/IEEE-bus command `--`

The *DELTATO STEPSIZE* softkey sets the delta marker step size to a quantity equal to the difference between the delta and reference markers.

The softkey is only presented when at least one delta marker is switched on.

IEC/IEEE-bus command

```
:CALCulate<1|2>:DELTamarker<1..4>:STEP 10HZ
```

Search Functions – SEARCH Key

The ESI offers numerous functions useful for peak/min. peak searching. The search functions can be used for marker as well as delta marker functions.

The setups applicable to the available search functions are performed in the *MARKER-SEARCH* menu.

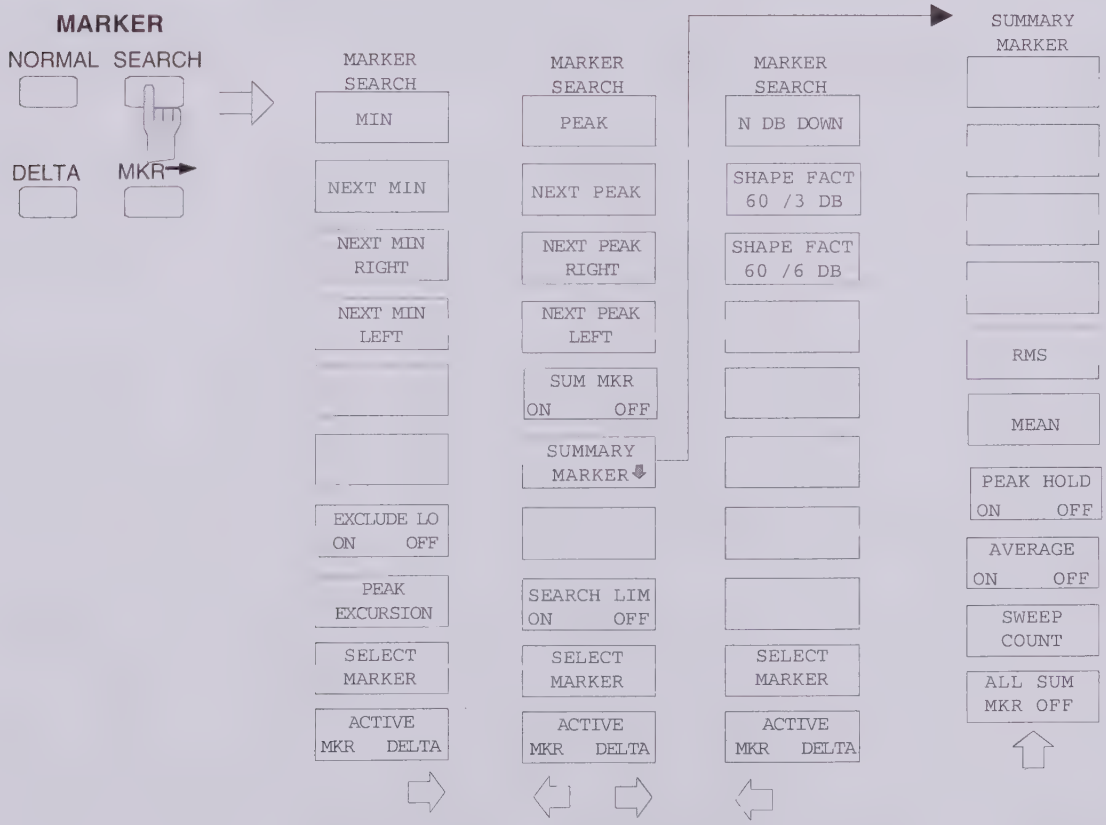
The search functions are always related to the currently active marker. If the *SEARCH* key is pressed while the marker entry mode is active, then all search functions are related to the current reference marker. If the entry mode of a delta marker is active, then the functions will be applied to the corresponding delta marker. For the case where no marker is active, *MARKER* 1 will be automatically enabled (with peak search). The *ACTIVE MKR / DELTA* softkey allows toggling between the active marker and the active delta marker.

If the threshold line is turned on, the peak/min. search functions will only evaluate signals which have a level above/below the selected threshold. In addition, the search range can also be limited (*SEARCH LIM ON/OFF* softkey) by the frequency/time lines (*FREQUENCY LINE 1/2, TIME LINE 1/2*).

For all peak search functions, the first local oscillator is omitted at 0 Hz if it happens to be displayed.

In the time domain display, the summary markers can be activated and set in addition to the search functions in menu *MARKER-SEARCH*.

MARKER SEARCH menu:



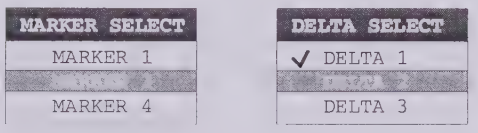
The *ACTIVE MKR / DELTA* softkey toggles between the active marker and the active delta marker.

If *DELTA* is illuminated, the following search functions are performed with the active delta marker.

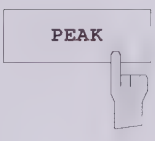
Note: *Switching between marker and delta marker entry modes may also be performed using the NORMAL and DELTA keys.*

IEC/IEEE-bus command --

The *SELECT MARKER* softkey activates the selection of the marker/delta markers. The selection box lists the currently enabled markers/delta markers.



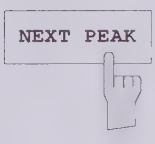
IEC/IEEE-bus command --



The *PEAK* softkey sets the active marker/delta marker to the maximum displayed value on the corresponding trace.

IEC/IEEE-bus commands

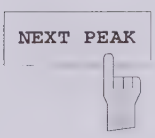
```
:CALCulate<1|2>:MARKer<1..4>:MAXimum
:CALCulate<1|2>:DELTamarker<1..4>:MAXimum
```



The *NEXT PEAK* softkey sets the active marker/delta marker to the trace value next in magnitude after the peak.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MAX:NEXT
:CALCulate<1|2>:DELTamarker<1..4>:MAX:NEXT
```



The *NEXT PEAK RIGHT* softkey sets the active marker to the next peak to the right of the current marker position.

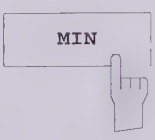
IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MAX:RIGHt
:CALCulate<1|2>:DELTamarker<1..4>:MAX:RIGHt
```

The *NEXT PEAK LEFT* softkey sets the active marker to the next peak to the left of the current marker position.

IEC/IEEE-bus commands

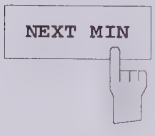
```
:CALCulate<1|2>:MARKer<1..4>:MAX:LEFT
:CALCulate<1|2>:DELTamarker<1..4>:MAX:LEFT
```



The *MIN* softkey sets the active marker to minimum displayed value on the corresponding trace.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MIN
:CALCulate<1|2>:DELTamarker<1..4>:MIN
```



The *NEXT MIN* softkey sets the active marker to the next higher of the low peaks on the corresponding trace.

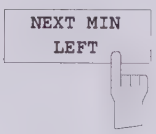
IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MIN:NEXT
:CALCulate<1|2>:DELTamarker<1..4>:MIN:NEXT
```

The *NEXT MIN RIGHT* softkey set the active marker to the next low peak to the right of the current marker position.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MIN:RIGHt
:CALCulate<1|2>:DELTamarker<1..4>:MIN:RIGHt
```



The *NEXT MIN LEFT* softkey sets the active marker to the next low peak to the left of the current marker position.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1...4>:MIN:LEFT
:CALCulate<1|2>:DELTamarker<1...4>:MIN:LEFT
```

The *EXCLUDE LO ON/OFF* softkey switches between a restriced (*ON*) and an unrestricted search range (*OFF*).

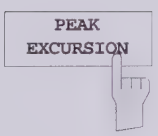
ON Because of non-ideal input mixer, the first LO of any analyzer can be seen at 0 Hz. The search functions can possibly respond to this LO level, in particular in the preset setting (FULL SPAN). To prevent this, the search range is restricted according to the following formula:

Search range ■ 6 ■ resolution bandwidth

OFF No restriction on the search range. The search functions find also signals below the frequency limit quoted above.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:LOEXclude ON|OFF
```



The *PEAK EXCURSION* softkey activates the entry box which sets the minimum amount a signal level must decrease/increase before it is recognised by the search functions (except PEAK and MIN) as a maximum or minimum.

Input values from 0 dB to 80 dB are allowed with a resolution of 0.1 dB.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:PEXCursion 10DB
```

The peak excursion is preset to 6 dB. This is sufficient for the functions *NEXT PEAK* (or *NEXT MIN*) as the next smallest (or next largest) signal is always searched for.

Functions *NEXT PEAK LEFT* and *NEXT PEAK RIGHT* (or *NEXT MIN LEFT and NEXT MIN RIGHT*) search for the next relative maximum (or minimum) irrespective of the current signal amplitude.
As for wide bandwidths, the intrinsic noise of the ESI may equal the 6 dB level change preset for *PEAK EXCURSION* and so noise peaks are identified as signal peaks
In this case, a value for *PEAK EXCURSION* which is higher than the difference between the maximum and minimum noise display reading must be entered.

The following example shows the effect of different *PEAK EXCURSION* settings.

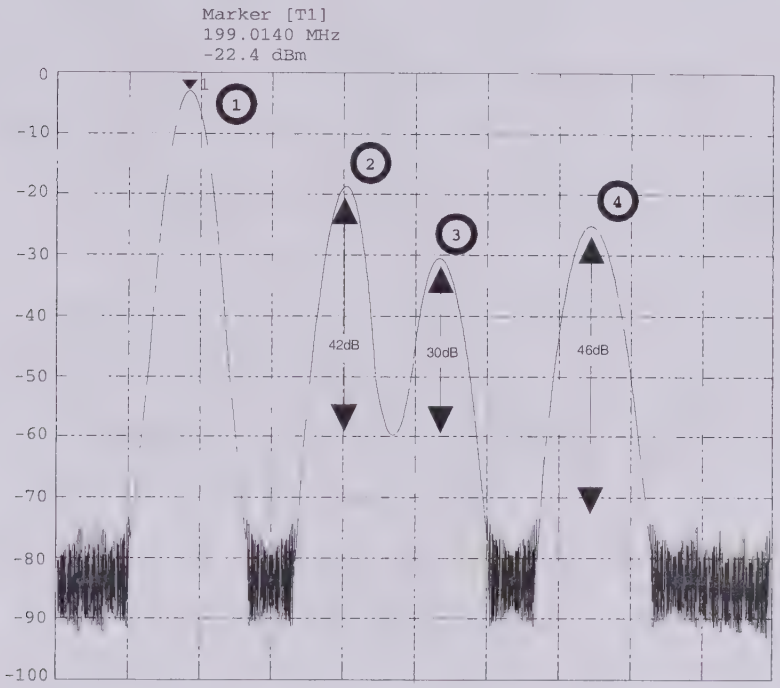


Fig. 4-12 Example for level measurements at various peak excursion settings

Maximum relative level change of the measured signals:

Signal 2:	42dB
Signal 3	30dB
Signal 4:	46dB

With **Peak Excursion 40dB** signals 2 and 4 are detected by *NEXT PEAK* or *NEXT PEAK RIGHT*. Signal 3 is not detected since it is only decreased by 30 dB before rising again.

Order in which signals are found:

PEAK:	Signal 1	or	PEAK:	Signal 1
NEXT PEAK:	Signal 2		NEXT PEAK RIGHT:	Signal 2
NEXT PEAK:	Signal 4		NEXT PEAK RIGHT:	Signal 4

With **Peak Excursion 20dB** signal 3 is detected as well since its highest level change of 30 dB is now higher than the peak excursion.

Order in which signals are found:

PEAK:	Signal 1	or	PEAK:	Signal 1
NEXT PEAK:	Signal 2		NEXT PEAK RIGHT:	Signal 2
NEXT PEAK:	Signal 4		NEXT PEAK RIGHT:	Signal 3
NEXT PEAK:	Signal 3		NEXT PEAK RIGHT:	Signal 4

Whith **Peak Excursion 6dB** all signals are detected, *NEXT PEAK RIGHT* does not produce the required results.

Order in which signals are found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2

The *SEARCH LIMIT ON/OFF* softkey switches between a limited (*ON*) and unlimited (*OFF*) search range.

For peak and min. search functions, the search range can also be limited by the frequency and time lines (FREQUENCY LINE 1, 2/TIME LINE 1, 2). If *SEARCH LIMIT = ON,* the appropriate signal level will only be searched for between the specified frequency/time lines.

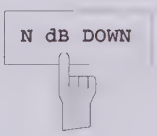
The default setting is *SEARCH LIMIT = OFF.*

When only one line is enabled, frequency/time line 1 is defined as the lower limit and the upper limit is defined by the stop frequency. If frequency/time line 2 turned on, then it determines the upper limit.

For the case in which no line is active the search range is unlimited.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:X:SLIMits ON|OFF
```



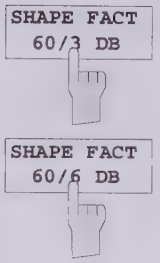
The *N dB DOWN* softkey automatically activates the temporary markers T1 and T2 and sets them n dB below the active reference marker. Marker T1 is located on the left, the marker T2 is located on the right of the reference marker. The value n can be entered in an entry window. The default value is 6 dB.

The frequency difference between the two temporary markers is indicated in the level output field.
If, e.g., due to the noise level, it is not possible to determine the frequency difference for the n dB value, dashes are displayed instead of the measured value.

Entry mode is switched to the reference marker for the case in which the delta maker entry mode is to be active. The position of the reference marker can be changed in the usual way (numeric input, step-keys, roll-key, peak search, etc.).
Pressing the *N dB DOWN* softkey again switches the function off, however, the entry function for the reference marker remains turned on.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NDBDown 3DB
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NDBDown:STATe ON
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NDBDown:RESult?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:NDBDown:FREQ?
```



The *SHAPE FACT 60/3dB*.and *SHAPE FACT 60/6dB* softkeys activate the automatic measurement of the form factor for the displayed signals.

For this purpose, four temporary markers are used. The markers T1 to T4 indicate, in increasing order, the 3 dB/6 dB positions below the reference marker level.

In the level output field, the relationship between the two frequency differences $\blacksquare f_{60dB} / \blacksquare f_{3dB}$ and $\blacksquare f_{60dB} / \blacksquare f_{6dB}$ are displayed

The display of the measurement value takes place in the marker field. When the level differences cannot be determined, the measurement value is marked as invalid. The update of the shape-factor display takes place at the end of sweep.

The entry mode is switched to the reference marker if the delta marker entry mode is to be active. The position of the reference marker can be changed in the usual way (numeric input, step-keys, roll-key, peak search, etc.).

The *SHAPE FACTOR* function is turned off by pressing *SHAPE FACTOR* softkey once again, or by enabling another marker.

The *SHAPE FACTOR* function is available only in the frequency domain.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SFACtor
                                    (60dB/3dB) | (60dB/6dB)
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SFACtor:STATe ON
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SFACtor:RESult?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SFACtor:FREQ?
```

Summary Marker

The summary markers are available for measurements in the time domain (SPAN = 0).

Unlike the markers and delta markers, the *summary markers* are not used to mark the pixels of a trace. They activate a measurement of the rms value (*RMS*) or of the average value (*MEAN*) of the whole trace. The result is displayed in the marker info field.

The measured values are either updated after every sweep or averaged according to a defined number of sweeps (*AVERAGE ON/OFF* and *SWEEP COUNT*). In case of maximum peak evaluation (*PEAK HOLD ON*) the measured values are held until the occurrence of the next higher value.

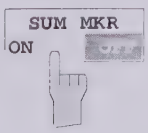
Example:
Marker info field switched on with summary marker: *MEAN*, *AVERAGE ON* and *PEAK HOLD ON*

```
MEAN HOLD      2.33 Watt
MEAN AV        2.29 Watt
```

The evaluation range can be limited with the function *SEARCH LIMITS ON* and the time lines (*TIME LINE1,2*), eg when measuring the average power of a sampled signal from the beginning to the end of a burst.

With the summary marker switched on, the sampling detector is activated (*TRACE-DETECTOR-AUTO*).

MARKER SEARCH menu



The *SUM MKR* softkey activates the summary marker

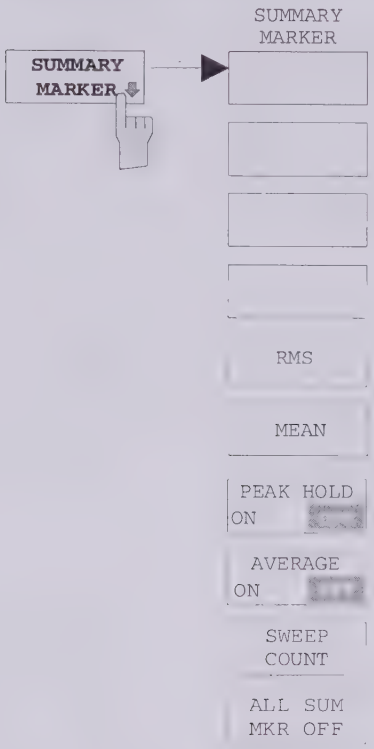
The measurement, rms or average value and the settings for maximum peak evaluation and averaging is selected in the submenu *SUMMARY MARKER*.

The softkey is only available in the time domain.

IEC/IEEE-bus command

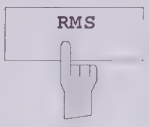
```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMMary ON|OFF
```

MARKER SEARCH menu



The *SUMMARY MARKER* softkey calls up the submenu for selecting the summary marker measurements.

The softkey is only available in the time domain.



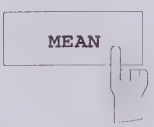
The *RMS* softkey selects the measurement of the rms value of the signal per sweep.

In case of maximum peak evaluation the highest rms value since the activation of *PEAK HOLD ON* is displayed. In case of *AVERAGE ON* the rms values of a trace are averaged and displayed over several sweeps.

The number of sweeps is set with the *SWEEP COUNT* softkey. If *PEAK HOLD = ON* is active at the same time, the display is held until the occurrence of the next higher average value.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:RMS ON
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:RMS:RES?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:RMS:AVER:RES?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:RMS:PHOL:RES?
```



The *MEAN* softkey selects the measurement of the average value of the signal per sweep.
Thus, the mean power can be measured, for example during a GSM burst.

In case of maximum peak evaluation, the highest average value since the activation of *PEAK HOLD ON* is displayed.

In case of *AVERAGE ON*, the average values of a trace are averaged and displayed over several sweeps.

The number of sweeps is set with the *SWEEP COUNT* softkey. If *PEAK HOLD = ON* is active at the same time, the display is held until the occurrence of the next higher average value.

IEC/IEEE-bus commands :

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:MEAN ON
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:MEAN:RES?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:MEAN:AVER:RES?
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMM:MEAN:PHOL:RES?
```

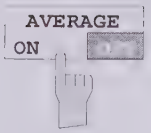
The *PEAK HOLD ON/OFF* softkey switches the maximum peak evaluation on and off.

For all active summary markers, the displays are updated after each sweep only if higher values have occurred.

The measured values can be reset by switching the *PEAK HOLD ON / OFF* softkey on and off again.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMMary:PHOLd ON
```



The *AVERAGE ON/OFF* softkey switches the averaging of the summary markers on and off.

The measured values can be reset by switching the *AVERAGE HOLD ON / OFF* softkey on and off again.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1...4>:FUNCtion:SUMMary:AVERage ON
```

The *SWEEP COUNT* softkey activates the entry of the number of sweeps in the *SINGLE SWEEP* mode.

The permissible range of values is 0 to 32767.

In case of *AVERAGE ON*:

If an averaging has been selected, SW*EEP COUNT* also determines the number of measurements required for averaging.

SWEEP COUNT = 0	10 measured values are required for running averaging.
SWEEP COUNT = 1	No averaging is carried out.
SWEEP COUNT > 1	An averaging is carried out over the set number of measured values.

In the *CONTINUOUS SWEEP* mode averaging is performed until the number of sweeps set under *SWEEP COUNT* is attained and then running averaging is performed.

The maximum peak evaluation is infinite independent of the entry under *SWEEP COUNT.*

Note: *This setting is equivalent to the settings of the number of sweeps of menus TRACE and SWEEP-SWEEP.*

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:COUNt 20`

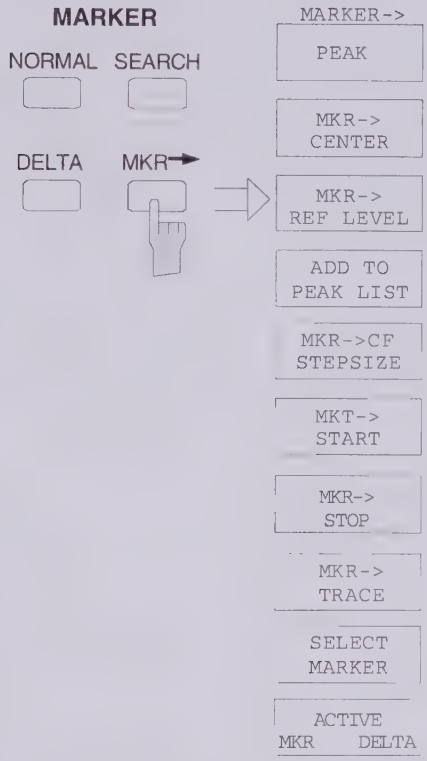
The *ALL SUM MKR OFF* softkey switches all the summary markers off.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:SUMMary:AOFF
```

Instrument Parameter Changes via Markers – MKR ■ Key

MARKER MKR →menu:



The *MKR* ■ menu offers functions that can be used to change instrument settings with the currently active marker. Exactly as in the *SEARCH* menu, these functions can also be applied to the delta markers.

The choice between marker and delta marker is made according to the currently active frequency entry mode for the marker/delta marker. If no entry mode is active, the marker with the lowest number will be activated as the reference marker.

The *ACTIVE MKR /DELTA* softkey toggles between the active marker and the active delta marker.

If *DELTA* is illuminated, the following marker functions are carried out with the active delta marker.

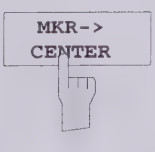
Note: *Switching between marker and delta marker can also be done with the NORMAL and DELTA keys.*

IEC/IEEE-bus command --

To simplify control, the *PEAK* search function (see section "Search Functions - *SEARCH Key")* is also available in the *MRK→* menu. Thus, the most important functions *MARKER→PEAK*, *MKR→CENTER* and *MKR→REF LEVEL* can be selected in one menu.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:MAX
:CALCulate<1|2>:DELTamarker<1..4>:MAX
```

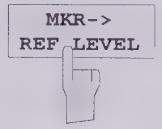


The *MKR→CENTER* softkey sets the center frequency to the current marker/delta marker frequency .

The softkey is not available in the time domain.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:CENTer
```



The *MKR→REF LEVEL* softkey sets the reference level to that of the current marker.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:REFerence
```

The *ADD TO PEAK LIST* softkey adds the frequency of the current marker to the peak list of the receiver mode (see also Section "Data Reduction and Subrange Maxima").

IEC/IEEE bus command --

The *MKR→CF STEPSIZE* softkey sets the step size for the center frequency variation to the current marker frequency, and also sets step-size adaptation to *MANUAL*. The *CF STEP SIZE* remains at this value until the center frequency entry mode in the STEP menu is switched from *MANUAL* to *AUTO* again.

The *MKR→CF STEPSIZE* function is, above all, useful when measuring harmonics with a large dynamic range (small bandwidth and small span).

The softkey is not available in the time domain.

IEC/IEEE-bus command

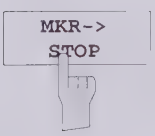
```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:CSTep
```

The *MKR→START* softkey sets the start frequency to the current marker frequency.

The softkey is not available in the time domain.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:STARt
```

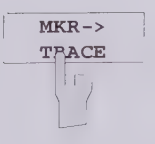


The *MKR→STOP* softkey sets the stop frequency to the current marker frequency.

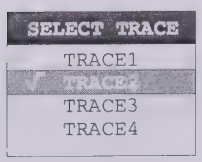
The softkey is not available in the time domain.

IEC/IEEE-bus command

```
:CALCulate<1|2>:MARKer<1..4>:FUNCtion:STOP
```



The *MKR→TRACE* softkey places the active marker on a new trace. The traces available for selection appear in the selection window.



IEC/IEEE-bus commands

```
:CALCulate<1|2>:MARKer<1..4>:TRACe 2
:CALCulate<1|2>:DELTamarker<1..4>:TRACe 2
```

Setup of Display and Limit Lines – *LINES* Key Field

Display Lines – *D LINES Key*

Display lines are aids which, similar to markers, make the evaluation of trace data more convenient. The function of display lines is similar to that of a movable scale which can be used to measure absolute and differential values on traces.
In addition, the display lines can also be used to limit the range of search for marker functions.

The ESI provides four different types of display lines:

- two horizontal threshold lines for setting levels or for defining level search ranges – Display Line 1/2,
- two vertical frequency/time lines for indicating frequencies/times or for determining frequency or time search ranges – Frequency/Time Line 1/2,
- a threshold line which, for example, sets the search threshold for maximum levels (Peak Search) – Threshold Line
- a reference line which serves as the basis for mathematical correlation between traces – Reference Line

For purposes of clarity, each line is annotated on the right side of the display diagram by the following abbreviations:

D1	Display Line 1	T1	Time Line 1
D2	Display Line 2	T2	Time Line 2
F1	Frequency Line 1	TH	Threshold Line
F2	Frequency Line 2	REF	Reference Line

The lines for level, threshold and reference are displayed as continuous, horizontal lines over the full width of the diagram. They are movable in the y-direction.
The lines for frequency and time are displayed as vertical, continuous lines over the total height of the diagram. They are movable in the x-direction.

For measurement operations in two separate windows, (Split Screen-Modus), the display lines are available independently in both windows. In the currently active window, the display lines can be activated and/or shifted. Lines previously defined in the currently inactive window remain unchanged.

The *LINES-D LINES* menu, used for switching on and setting the display lines, is dedicated to the chosen display in the active measurement window (span or time). For the display of a spectrum (span ■ 0), the *FREQUENCY LINE 1* and *FREQUENCY LINE 2* softkeys appear, For the time display (span = 0), the *TIME LINE 1* and *TIME LINE 2* softkeys are displayed.

Note: *The softkeys for setting and switching the display lines on and off operate similar to a three-position switch:*

Initial condition: The line is switched off (softkey has grey background)

1st press: The line is switched on (softkey has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If some other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (softkey has green background).

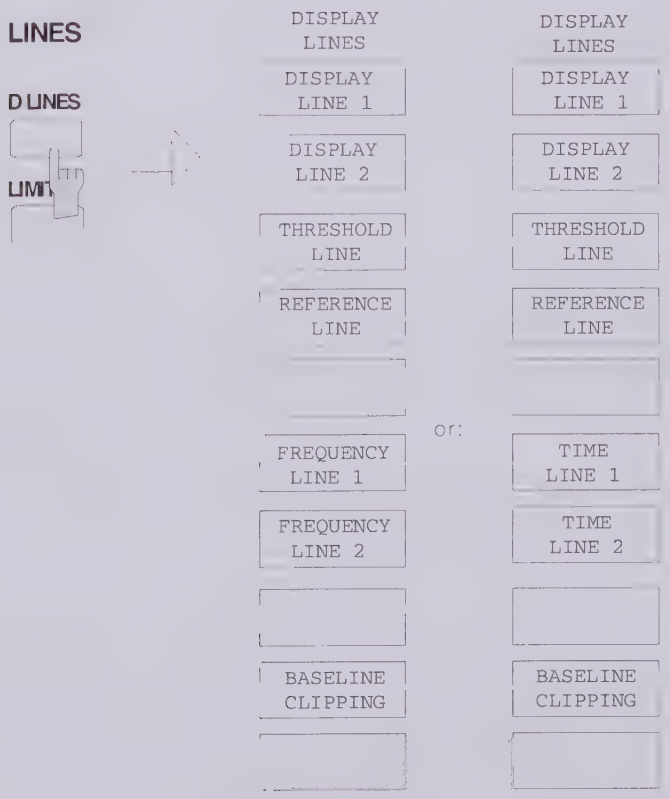
2nd press: The display line is switched off (softkey has grey background).

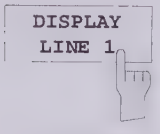
Initial condition: The line is switched on (softkey has green background)

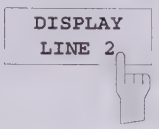
1st press: The line is switched on (softkey has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If any other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (softkey has green background).

2nd press: The display line is switched off (softkey has grey background).

Menu *LINES-D-LINES* for Span ■ 0 for Span = 0





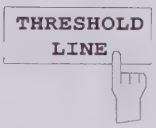


The *DISPLAY LINE 1/2* softkeys switch the display lines on/off and activate the entry of the line location.

The display lines mark the selected levels in the measurement window.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:DLINe<1|2>:STATe  ON | OFF;
:CALCulate<1|2>:DLINe<1|2> -20dBm
```

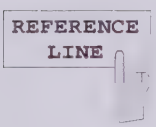


The *THRESHOLD LINE* softkey switches the threshold line on/off and activates the entry of the line location.

The threshold line is a display line which defines a threshold value. This threshold value serves as a lower search limit for maximums/minimums in the marker functions (*MAX PEAK, MIN PEAK, NEXT PEAK* etc.). For signal tracking (*SIGNAL TRACK function*), this threshold value defines the lower search limit (see section "Marker Functions")..

IEC/IEEE-bus commands

```
:CALCulate<1|2>:THReshold ON | OFF;
:CALCulate<1|2>:THReshold -82dBm
```

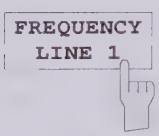


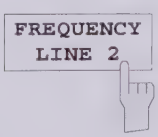
The *REFERENCE LINE* softkey switches the reference line on/off and activates the entry of the line position.

The reference line serves as the basis for mathematical correlation between trace data (see section "Mathematical Operations on Measurement Curves"

IEC/IEEE-bus commands

```
:CALCulate<1|2>:RLINe:STATe ON | OFF;
:CALCulate<1|2>:RLINe -10dBm
```



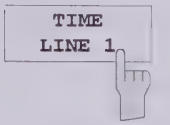


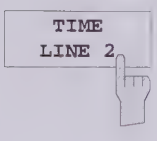
The *FREQUENCY LINE 1/2* softkeys switch the frequency lines 1/2 on/off and activate the entry of the line locations.

The frequency lines mark the selected frequencies in the measurement window or define search ranges (see section "Marker Functions").

IEC/IEEE-bus commands

```
:CALCulate<1|2>:FLINe<1|2>:STATe ON | OFF;
:CALCulate<1|2>:FLINe<1|2> 120 MHz
```





The *TIME LINE 1/2* softkeys switch the time lines 1/2 on/off and activate the entry of line locations.

The time lines mark the selected times or define the search range (see section "Marker Functions").

IEC/IEEE-bus commands

```
:CALCulate<1|2>:TLINe<1|2>:STATe ON | OFF;
:CALCulate<1|2>:TLINe<1|2> 10ms
```

The *BASELINE CLIPPING* softkey switches on or off the *BASELINE CLIPPING* function and allows a limit value to be entered.

The *BASELINE CLIPPING* function is for blanking measured values (for example noise) which are below a preset threshold.
If the *BASELINE CLIPPING* function is active and a measured value is below the preset threshold, the value is set to a lower boundary (-400 dBm). Measured values above the clipping level are not changed.

Note: *It is advisable not to combine the BASELINE CLIPPING function with the AUTOPEAK detector.*
If the set clipping value is within the displayed noise band (AUTOPEAK detector), activation of the CLIPPING function and the resulting clipping of the MIN PEAK values will lead to a drastic enlargement of the displayed noise band.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:CTHReshold:STATe ON | OFF
:CALCulate<1|2>:CTHReshold -82dBm
```

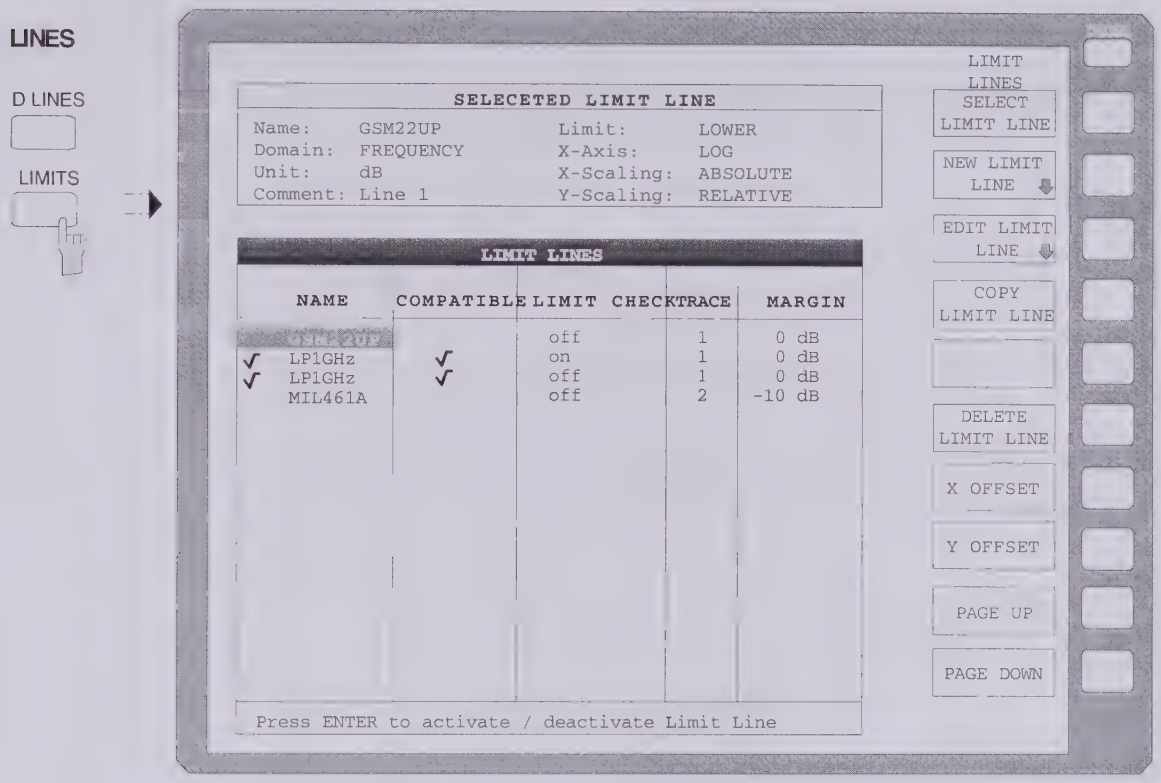
Limit Lines – *LIMITS Key*

Limit lines are used to define limits for amplitude curves or spectral distributions on the screen. They indicate, for example, the upper limits for interference radiation or spurious waves which are permissible from a Unit Under Test (UUT). In the case of TDMA transmissions (e.g., GSM), the amplitude curve of the bursts in a time slot must fall within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be cecked either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).
The ESI instrument supports up to 300 limit lines, each of which may have a maximum of 50 data points. For each limit line, the following characteristics must be defined:

- The name of the limit line. The limit line is stored under this name and is diplayed in the *LIMIT LINES* table.
- The domain in which the limit line is to be used. A distinction is made between the time domain (span = 0 Hz) and the frequency domain (span > 0 Hz).
- The X-coordinates of the interpolation points. The limit line can be specified either in terms of absolute frequencies or times or in terms of frequencies referred to the set center frequency and times referred to the time represented by the left-hand edge of the diagram.
- The Y-coordinates of the interpolation points. The limit line can be selected either for absolute levels or voltages or referred to the set maximum level (Ref Lvl or Max Lvl). If the reference line is switched on, it is used as reference when relative setting has been selected.
- The type of limit line (upper or lower limit). With this definition and the limit checking function on (*LIMIT CHECK*), the ESI checks for compliance with each limit.
- The limit line units. The units for the limit line must be compatible with the level axis in the active measurement window.
- The trace to which the limit line is assigned. For the ESI, this defines the trace to which the limit is to be applied when several traces are simultaneously displayed.
- For each limit line, a margin can be defined which serves as a threshold for automatic evaluation.
- A comment can also be entered for each limit line, e.g., a description of the application.

In the *LINES LIMIT* menu, the compatible limit lines can be enabled in the *LIMIT LINES* table. The *SELECTED LIMIT LINE* display field provides information about the characteristics of the marked limit lines. New limit lines can be specified and edited in the *NEW LIMIT LINE and EDIT LIMIT LINE* sub-menus.

LINES LIMIT menu

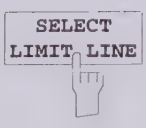


Limit Line Selection

The *SELECTED LIMIT LINES* table provides information about the characteristics of the marked limit line :

Name	name
Domain	frequency or time
Limit	upper/lower limit
X-Axis	linear or logarithmic interpolation
X-Scaling	absolute or relative frequencies/times
Y-Scaling	absolute or relative Y-units
Unit	for vertical scale
Comment	comment

The characteristics of the limit line are set in the *EDIT LIMIT LINE (=NEW LIMIT LINE)* submenu.



The *SELECT LIMIT LINE* softkey activates the *LIMIT LINES* table and the selection bar jumps to the uppermost name in the table.

The columns headfings are as follows:

Name	NAme of the limit line to be selected.
Compatible	Indicates if the limit line is compatible with the measurement window of the given trace.
Limit Check	Activates the automatic "within limits" check.
Trace	Selects the trace to which the limit is assigned.
Margin	Defines a margin.

Name and Compatible - Switching on limit lines

A maximum of 8 limit lines can be switched at any one time. A check mark at the left edge of a cell indicates that this limit line is switched on. A limit line can only be switched on when it has a check mark in the *Compatible* column, i.e., only when the display mode of the x-axis (time or frequency) and y-axis units are ***identical*** to those in the measurement window.

It should be noted that lines with dB scales are compatible with all dB(..) scales of the Y-axis.
If the trace assigned to a line is not switched on, the line is displayed in the window the trace would be displayed in.

Example:
In split screen mode, trace 2 is assigned measuring window B. A line assigned to trace 2 is always displayed in measurement window B.

If the y-axis unit or the domain (frequency or time) are changed, all non-compatible limit lines are automatically switched off in order to avoid misinterpretations. The limit lines must be switched on again when the original display mode is restored.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:NAME <string>;
:CALCulate<1|2>:LIMit<1..8>:STATe ON | OFF
```

Limit Check - Activating the limit check

When *LIMIT CHECK ON* is activated, a limit check is performed automatically on the active screen. In the center of the screen, a display window containing the results of the limit check test appears:

LIMIT CHECK: PASSED	No out-of-limits conditions.
LIMIT CHECK: FAILED	One or more out-of-limits conditions. The message contains the names of the limit lines which were violated or whose margins were not complied with.
LIMIT CHECK: MARGIN	The margin of at least one active limit line was not complied with, however, no limit line was violated. The message contains the names of the limit lines whose margins were not complied with.

The following example shows three active limit lines:

```
LIMIT CHECK: FAILED

LINE VHF_MASK: Failed
LINE UHF2MASK: Margin
```

A limit check is performed only if the trace associated with the limit line is turned on.
If *LIM CHECK* is set to *OFF* for all active limit lines, then the limit line check is not executed and the display field not activated.

IEC/IEEE-bus command `:CALCulate<1|2>:LIMit<1...8>:FAIL?`

***Trace* - Selecting the trace to which the limit line is assigned.**

The trace is selected in an entry window. An integer entries 1, 2, 3 or 4 indicating the trace is entered. The default setting is trace 1. If the selected limit line is not compatible with the assigned trace, the limit line is disabled. (display and limit check).

IEC/IEEE-bus command

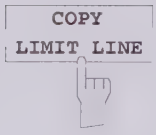
```
:CALCulate<1|2>:LIMit<1...8>:TRACe 1|2|3|4
```

***Margin* - Setting a margin.**

The margin is defined as the level difference between the limit line and the signal . When the limit line is defined as an upper limit, the margin means that the level is below the limit line. When the limit line is defined as a lower limit, the margin means that the level is above the limit line. The default setting is 0 dB (i.e., no margin).

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:UPPer:MARGin 10DB
:CALCulate<1|2>:LIMit<1..8>:LOWer:MARGin 10DB
```



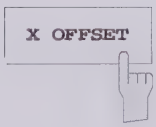
The *COPY LIMIT LINE* softkey copies the data set of the marked limit line and saves it under a new name. In this way, a new limit line can be easily generated by parallel translation or editing of an existing limit line. The name can be arbitrarily chosen and input via an entry window (max. of 8 characters).

IEC/IEEE-bus command

```
:CALCulate<1|2>:LIMit<1..8>:COPY 1..8|<name>
```

The *DELETE LIMIT LINE* softkey erases the selected limit line. Before deletion, a message appears requesting confirmation.

IEC/IEEE-bus command `:CALCulate<1|2>:LIMit<1...8>:DELete`



The *X OFFSET* softkey horizontally shift a limit lines which has been specified for relative frequencies or times (X-axis). The softkey opens an entry window, where the value for shifting may be entered numerically or via the roll-key.

Note: *When changing the start or the stop frequency, the line on the display only remains unchanged, if SPAN FIXED is set.*

IEC/IEEE-bus command

```
:CALCulate<1|2>:LIMit<1..8>:CONT:OFFSet 100us
```

The *Y OFFSET* softkey vertically shifts a limit line, which has relative values for the Y-axis (levels or linear units such as volt). The softkey opens an entry window where the value for shifting may be entered numerically or via the roll-key.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:UPP:OFFSet 3dB
:CALCulate<1|2>:LIMit<1..8>:LOW:OFFSet 3dB
```

Entering and Editing of Limit Lines

A limit line is characterized by

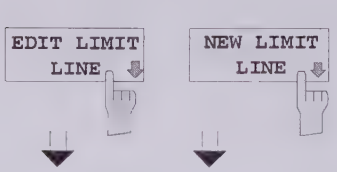
- its name
- the domain assignment (frequency or time)
- whether the scale is absolute or relative (time or frequency)
- linear or logarithmic interpolation
- the vertical unit
- the vertical scale
- the definition of the limit line as either an upper or lower limit.
- the interpolation points for frequency/time and level

When the limit line is entered, the ESI immediately checks all limit lines according to rules that guarantee correct operation.

- The frequencies/times for each interpolation point must be entered in ascending order, however, for any single frequency/time, twodata points may be entered (vertical segment of a limit line).

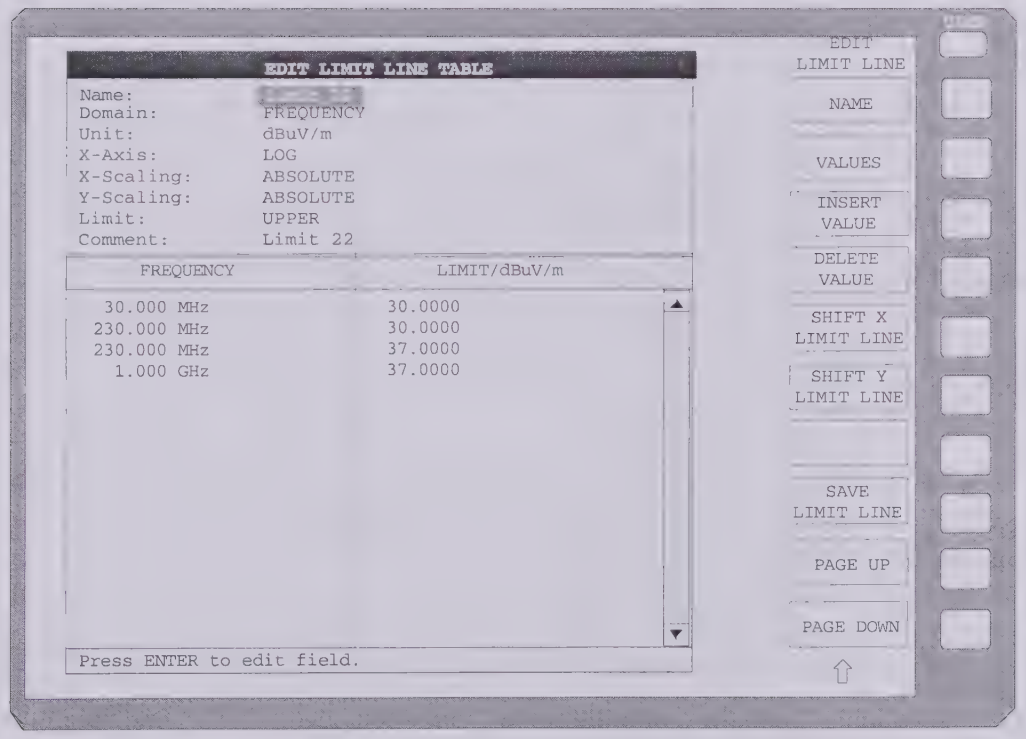
  The interpolation points are allocated in order of ascending frequency/time. Gaps are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies/times need not necessarily be capable of selection on the ESI. A limit line may also exceed the frequency or time display range. The minimum frequency for an interpolation point is -200 GHz, the maximum frequency is 200 GHz. For the time domain, negative times may also be entered. The range is -1000 s to +1000 s.
- The minimum/maximum value for a limit line is -200 dB/ +200 dB for the logarithmic scale or 10^{-20}/ 10^{+20} or-99.9%/ + 999.9% for linear amplitude scales.

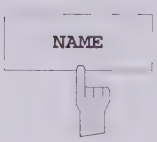
LINES LIMIT-EDIT LIMIT LINE menu



The *EDIT LIMIT LINE* and *NEW LIMIT LINE* softkeys both call the *EDIT LIMIT LINE* submenu used for editing limit lines. In the table heading, the characteristics of the limit line can be entered. The frequency/time and level points are entered in the columns.

Name	Enter name.
Domain	Select domain.
Unit	Select units.
X-Axis	Select interpolation
X-Scaling	Entry of absolute or relative values for the X-axis
Y-Scaling	Entry of absolute or relative values for the Y-axis
Limit	Select upper/lower limit.
Comment	Enter comments.
Time/Frequency	Enter time/frequency points.
Limit/dBm	Enter level points.





The *NAME* softkey activates the entry of characteristics in the table heading.

***Name* - Entry of name**

A maximum of 8 characters are permitted for each name. All names must be compatible with the MS DOS conventions for file names. The instrument automatically stores all limit lines with the .LIM extension.

IEC/IEEE-bus command

```
:CALCulate<1|2>:LIMit<1...8>:NAME <string>
```

***Domain* - Selection of time or frequency domain**

The domain (frequency/time) can only be changed when the limit-line point table is empty. The default setting is frequency.

IEC/IEEE-bus command

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:DOMain FREQ | TIME
```

***X-Axis* - Indication of interpolation**

Linear or logarithmic interpolation can be carried out between the frequency reference points of the table. The ENTER key toggels between LIN and LOG selection.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:SPACing LIN | LOG
:CALCulate<1|2>:LIMit<1..8>:UPPer:SPACing LIN | LOG
:CALCulate<1|2>:LIMit<1..8>:LOWer:SPACing LIN | LOG
```

***Scaling* - Selection of absolute or relative scale**

The limit line scale can either be absolute (frequency or time) or relative. Any of the unit keys may be used to toggle between *ABSOLUTE* and *RELATIVE*, the cursor must in the X-*Scaling* or the *Y-Scaling* line

X-Scaling ABSOLUTE	The frequencies or times are interpreted as absolute physical units.
X-Scaling RELATIVE	The frequencies in the limit-line point table are referred to the currently set center frequency. In the time domain, the left boundary of the diagram constitutes the reference.
Y-Scaling ABSOLUTE	The limit values are absolute levels or voltages.
Y-Scaling RELATIVE	The limit values refer to the reference level or, in case a reference line is set, to the reference line. Limit values in dB or % are always relative values.

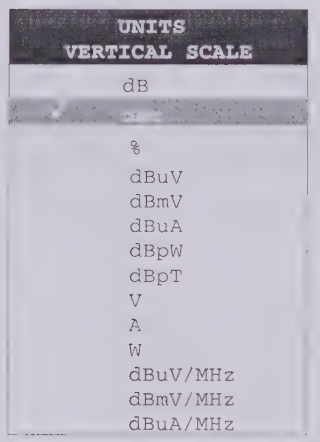
RELATIVE scaling is always recommended, if masks for bursts are to be defined in the time domain, or if masks for modulated signals are required in the frequency domain.
An X-offset equal to half the sweep time may be entered to shift the mask in the time domain to the center of the screen.

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:MODE  REL | ABS
:CALCulate<1|2>:LIMit<1..8>:UPPer:MODE  REL | ABS
:CALCulate<1|2>:LIMit<1..8>:LOWer:MODE  REL | ABS
```

Unit - Selection of the vertical scale units for the limit line

Units are selected in a selection box. The default setting is dBm.



IEC/IEEE-bus command `:CALCulate<1|2>:LIMit<1...8>:UNIT DB| DBM| PCT |DBUV| DBMW | DBUA | DBPW| DBPT | WATT| VOLT | AMPere | DBUV_MHZ | DBMV_MHZ| DBUA_MHZ | DBUV_M | DBUV_MMHZ | DBUA_M | DBUA_MMHZ`

Limit - Selection of upper/lower limit

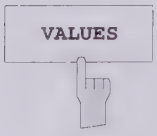
A limit line can be defined as either an upper or lower limit.

IEC/IEEE-bus command `--`
`(defined by the key words :UPPer or :LOWer)`

Comment - Enter comments

Comments are user selectable, but may not exceed 40 characters in length.

IEC/IEEE-bus command
`:CALCulate<1|2>:LIMit<1..8>:COMMent 'string'`

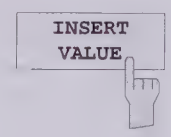


The *VALUES* softkey activates the entry of the data points in the table columns *Time/Frequency* and *Limit/dB*. Which table column appears depends on the *Domain* selection in the table heading.

The frequency/time points are entered in ascending order (two repeated frequencies/times are permitted).

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1...8>:CONTrol[:DATA]
                             <num_value>, <num_value>..
:CALCulate<1|2>:LIMit<1...8>:UPPer[:DATA]
                             <num_value>, <num_value>..
:CALCulate<1|2>:LIMit<1...8>:LOWer[:DATA]
                             <num_value>,<num_value>..
```

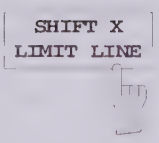


The *INSERT VALUE* softkey creates an empty line above the current cursor position where a new data point can be entered. However, when entering new values, the ascending order for frequency/time values must be kept.

IEC/IEEE-bus command --

The *DELETE VALUE* softkey erases the data point (complete line) at the cursor position. The data points that follow are moved along to fill the gap.

IEC/IEEE-bus command --



The *SHIFT X LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted horizontally.

The shift units are the same as the horizontal scale units:

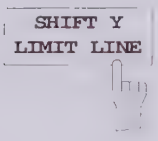
– in the frequency domain in Hz, kHz, MHz or GHz

– in the time domain in ns, µs, ms or s

This means that it is easy to create a new limit line from existing limit line which has been shifted horizontally and stored (*SAVE LIMIT LINE* softkey) under a new name (*NAME* softkey).

IEC/IEEE-bus command

```
:CALCulate<1|2>:LIMit<1..8>:CONTrol:SHIFt 50kHz
```



The *SHIFT Y LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted vertically.

The shift units are the same as the vertical scale units:

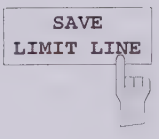
– for relative logarithmic units in dB

– for linear units, as a factor

This means that a new limit line can easily be created from an existing limit line which has been shifted vertically and stored (*SAVE LIMIT LINE* softkey) under a new name (*NAME* softkey).

IEC/IEEE-bus commands

```
:CALCulate<1|2>:LIMit<1..8>:UPPer:SHIFt 20dB
:CALCulate<1|2>:LIMit<1..8>:LOWer:SHIFt 20dB
```



The *SAVE LIMIT LINE* softkey stores the currently edited limit line . The name can be entered in an entry window (max. 8 characters)

IEC/IEEE-bus command -- (automatically executed)

Trace Selection and Setup – *TRACE Key Group*

The ESI can display up to four separate traces at a time on a screen. A trace has of a maximum of 500 pixels along the horizontal axis (frequency or time). If more measured values than pixels are available, several measurement values are assigned to one pixel.

The traces are selected using keys 1 to 4 of the *TRACES* key group. When two measurement windows (*SPLIT SCREEN*) are displayed, traces 1 and 3 are assigned to the upper (*SCREEN A)* and traces 2 and 4 are assigned to the lower (*SCREEN B)* measurement window.

The traces can be individually activated for a measurement or frozen after completion of a measurement. Traces that are not activated are not displayed.

A display mode can be selected for each trace. The traces can be overwritten (CLEAR/WRITE mode) after each sweep, averaged (AVERAGE mode) over several sweeps, or the maximum/ minimum value from several sweeps can be displayed (MIN HOLD/MAX HOLD).

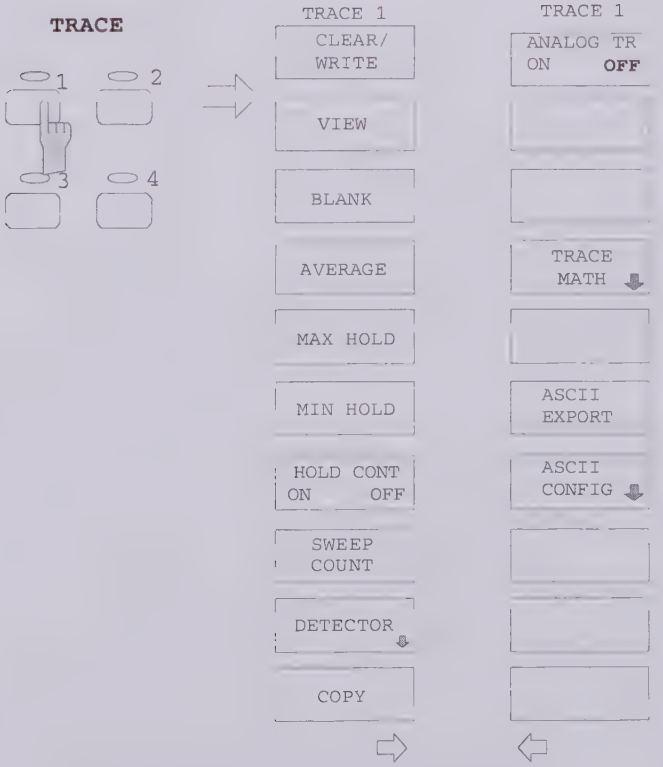
Individual detectors are selectable for each of the traces. The auto-peak detector displays the maximum and minimum values on a vertical line. The max-peak detector and min-peak detector display the maximum and /minimum levels represented by a pixel. The sampling detector displays the instantaneous value of the level at a pixel. The rms detector displays the power (rms) of the spectrum at a pixel, the average detector the average value.

Measurement Function Selection - *TRACE 1 to 4* key

The trace functions are categorized as follows:

- type of trace display (CLEAR/WRITE, VIEW and BLANK)
- evaluation of the trace as a whole (AVERAGE, MAX HOLD and MIN HOLD)
- evaluation of the individual pixels of a trace (AUTOPEAK, MAX PEAK, MIN PEAK, SAMPLE, RMS and AVERAGE)

TRACE 1 menu



The *TRACE* keys 1...4 call a menu whith the setting options for the selected trace.

This menu is used to determine the method for compressing the measurement data in the frequency or time domain to the 500 representable points of the display is determined.

When the measurement is started, a new trace can be displayed or the trace can be based on previous results. The traces can be displayed, blanked and copied.

By applying mathematical functions, the traces can also be corrected.

The measurement detector for each of the display types may be chosen either directly or selected automatically by the ESI.

All activated traces are marked with a LED at the corresponding key (here, *TRACE 1)*. The default setting is *TRACE 1* with *CLEAR / WRITE* selected. The remaining traces 2...4 are switched off (*BLANK*). For the split screen display, the selection of the trace automatically selects the corresponding screen for entry.

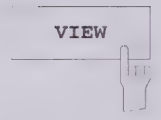
Only one of the *CLEAR/WRITE, MAX HOLD, MIN HOLD, AVERAGE, VIEW* and *BLANK* softkeys can be activated at any one time.

The *CLEAR/WRITE* softkey activates the clear/write display mode.
The trace is displayed without additional trace evaluation. The trace memory is overwritten by each sweep. If more than one data point falls within a pixel, the trace is displayed in bar form with the maximum and minimum values being assigned to one pixel. In the clear/write display mode, all the available detectors are selectable. The autopeak detector is selected in the default mode (detector to *AUTO*).

Whenever the *CLEAR/WRITE* softkey is pressed, the ESI clears the selected trace memory and restarts the measurement.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE WRITe
```



The *VIEW* softkey freezes the current contents of the trace memory and displays them.

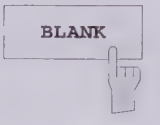
If the trace data were formed through *MAX HOLD*, *MIN HOLD* or *AVERAGE*, the sweep is restarted and the trace contents are cleared, after switching to these trace modes.

If a trace is frozen by *VIEW*, the instrument settings can be modified without modifying the displayed trace. The fact that the trace and the current instrument setting do not agree anymore is indicated by an enhancement label "*" at the right edge of the grid. The initial instrument setting can be restored using the *ADJUST TO TRACE* softkey in the *TRACE MATH* sub-menu.

If *LEVEL RANGE* or *REF LEVEL* is changed in the *VIEW* display mode, the ESI adjusts the measurement data to the changed display range. Thus, an amplitude zoom can be performed after the measurement so that details of the trace can be seen better.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE VIEW
```



The *BLANK* softkey activates the blanking of the trace.
However, the trace remains stored in memory and can be displayed again by pressing *VIEW*. The markers for the blanked trace are also erased. After reactivation of the trace (with *VIEW, CLEAR / WRITE, MAX HOLD, MIN HOLD, AVERAGE*) the markers will be restored their their previous positions.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4> OFF
```

The *AVERAGE* softkey activates the trace averaging function. The average is formed over several sweeps. The average can be calculated for each available detector. If the detector is automatically selected by the ESI , the sampling detector is used.

After enabling the averaging mode, the first trace is recorded in *CLEAR/WRITE* mode with the selected detector. After the second sweep, the average is then formed for each succeeding sweep. Here, the average is formed over the samples/pixels, i.e., according to the LIN or LOG setting, over amplitudes or levels.

Averaging is restarted every time the *AVERAGE* softkey is pressed. The trace memory is also cleared. This is also the case when the trace is switched from the setting *AVERAGE* to *VIEW* or *BLANK*

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE  AVER
```

Description of averaging:

Averaging is carried out using the pixels which are derived from the measurement value samples. These pixels may in some cases be comprised of several combined measurement values. This means that the average is formed over linear amplitude values when the level display is linear and over levels when the level display is logarithmic. Because of this, the trace must be measured anew when changing between the LIN and LOG display mode. The settings *CONT/SINGLE SWEEP* and the sliding average apply to the average display analogously.

Two calculation procedures are available for averaging. For *SWEEP COUNT*= 0 , a sliding average is calculated using the following equation:

$$TRACE_n = \frac{9 * TRACE_{n-1} + Meas\_Value}{10}$$

Because of the relative weighting of the new measurement value and the trace average, past values have practically no no influence on the displayed trace after about 10 sweeps. For this setting, the signal noise is effectively reduced without the need to restart the averaging process even if the signal is changed.

If the *SWEEP COUNT* is >1 averaging takes place over the selected number of sweeps. In this case, the displayed trace is given by the following formula during averaging::

$$TRACE_n = \frac{1}{n}\left[\sum_{i=1}^{n-1} T_i + Meas\ Value\right]$$

where n is the number of the current sweep (n = 2 ... SWEEP COUNT). For the first sweep, an average is not calculated. The measurement values are stored directly in trace memory. With growing n, the displayed trace becomes increasingly smoother since more individual trace data are available for averaging.
The average is stored in trace memory after the defined number of sweeps. Until this number of sweeps is reached, a preliminary average is displayed.

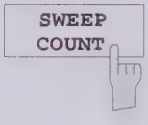
On completion of averaging, ie when the number of sweeps defined with *SWEEP COUNT* has been reached, a sliding average given by the following formula is obtained with *CONTINUOUS SWEEP*

$$TRACE_n = \frac{(N-1)\cdot TRACE_{n-1} + \text{Meas Value}}{N}$$

, where Trace = new trace
$Trace_{old}$ = old trace
N = SWEEP COUNT

The display "Sweep 200 of 200" then remains constant until there is a new start.

In *SINGLE SWEEP* mode, *SWEEP START* initiates n single sweeps. The sweeps are stopped as soon as the selected number of sweeps has been reached. The number of the current sweep and the total number of sweeps are shown in the display: "Sweep 3 of 200".

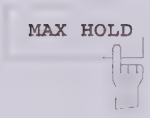


The *SWEEP COUNT* softkey activates the entry of the number of sweeps used for averaging.
The range for SWEEP COUNT is 0 through 32767. For 0, the ESI performs a sliding average over 10 sweeps. For 1, no averaging takes place.

The default setting is 10 sweeps. The programming naturally influences the sweep duration. The number of sweeps used for averaging is the same **for all 4 traces**.

Note : *The setting of the SWEEP COUNT in the trace menu is equivalent to the setting in the sweep menu.*

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:COUNt 10`



The *MAX HOLD* softkey activates the max hold mode.
In this display mode, the ESI saves for each sweep the largest of the previously stored/currently measured values in the trace memory. The detector is set automatically to *MAX PEAK*. In this way, the maximum value of a signal can be determined over several sweeps.

This is especially useful for measurement of modulated or pulsed signals. The signal spectrum is built up sweep by sweep until all the signal components have been captured.

Pressing of the *MAX HOLD* softkey again clears the trace memory and restarts the max hold mode.

If *MAX HOLD* is enabled, a new start is made after clearing the trace memory for each frequency change, (start frequency, stop frequency, center frequency or frequency span), a reference level change or switching between linear/logarithmic scales.

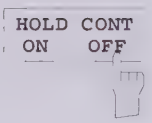
IEC/IEEE-bus command
`:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE MAXH`

The *MIN HOLD* softkey activates the min hold mode.
In this display mode, the ESI saves for each sweep the smallest of the previously stored/currently measured values in the trace memory. The detector is set automatically to *MIN PEAK*. In this way, the minimum value of a signal can be determined over several sweeps. This function is, e.g., useful for making an unmodulated carrier in a signals mixture easier to see on the display. Noise, interference or modulated signals are suppressed by the *MIN HOLD* function, whereas a CW signal maintains a constant level.

Pressing the *MIN HOLD* softkey clears the trace memory and the minimum value function starts anew.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE MINH
```



The *HOLD CONT* softkey defines whether the traces in the average mode and min hold/max hold mode are reset after some definite parameter changes.

OFF The traces are reset after some definite parameter changes.

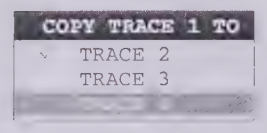
ON This mechanism is switched off.

In general, parameter changes require a restart of the measurement before results are evaluated (e. g. with markers). For those changes that are known to require a new measurement (e. g. modification of the span), the trace is automatically reset so that erroneous evaluations of previous results are avoided.
This mechanism can be switched off for those exceptional cases where the described behavior is unwelcome.

IEC/IEEE-bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE HCON ON|OFF
```

The *COPY* softkey copies the current trace as display on the screen to another trace memory. A table appears in which the copy procedure can be selected.



For only one window, the selected trace can be copied to any of the other trace memories since here, all four traces are displayed in one diagram with the same frequency boundaries.
In the split screen display, this is only possible as long as the frequencies of screen A and screen B are identical. If this is not the case, the selected trace can only be copied to the corresponding trace memory, i.e., trace 1 to trace 3 and trace 2 to trace 4 or vice versa. In this case, only the available trace is displayed.

After copying, the contents of the destination memory are lost. The destination memory now changes automatically to view mode with the new data.

IEC/IEEE-bus command

```
:TRACe:COPY  TRACE1| TRACE2| TRACE3| TRACE4,
             TRACE1| TRACE2| TRACE3| TRACE4
```

Detector Selection

The ESI detectors are rall-digital. The detectors available are the max-peak detector which derives the maximum value from a number of sample values, the min-peak detector which derivess the minimum value from a number of sample values and the sampling detector. The sampling detector passes on the sampled data without modification or performs a data reduction by suppressing non-displayable values. The peak detectors compare the current level with the maximum/minimum levels of the previously sampled data. When the number of samples defined by the instrument settings is reached, the samples are combined as displayable pixels. Each of the 500 pixels of the display therefore represents 1/500 of the sweep range and so all the individual measurements (frequency samples) that fall within this subrange in a compressed form. Even though the recording rate is high, there are no recording gaps thanks to the internal pipeline structure. For each trace display mode, an optimized detector is selected automatically. Since the peak detectors and the sample detector are connected in parallel, a single sweep is sufficient for record and display four traces with four detectors.

Peak value detectors (*MAX PEAK / MIN PEAK*)

Peak value detectors are implemented with digital comparators. For each of the levels measured at each of the frequencies represented by one of the 500 pixels, they determine the maximum (max peak) of all positive peaks and the minimum (min peak) of all the negative peaks.
This is repeated for each pixel so that, for wide frequency spans and inspite of the limited display resolution, a larger number of measurements than would otherwise be possible can be used to display the spectrum.

AUTOPEAK detector

The *AUTOPEAK* detector combines the two peak detectors. The max-peak detector and min-peak detector determine the maximum and minimum level over a displayed pixel at the same time and display it as a common measurement value. The maximum and minimum level over a frequency point are joined with a vertical line.

SAMPLE detector

The *SAMPLE* detector passes on all sampled data without further evaluation and either displays them directly or, for speed (short sweep times), first writes them to a memory and subsequently processes them.

Data reduction, i.e., summing of measurement values of neighboring frequencies or time samples is not performed here. If, during a sweep, more measurement values are generated than can be displayed, measurement values will be lost. Discrete signals can thus be lost

Therefore, the sampling detector can only be recommended for a ratio of span-to-resolution bandwidth of up to approximately 250. To ensure that no signal will be suppressed (example: span 1 MHz --> min. bandwidth 5 kHz).

RMS detector

The rms detector finds the rms value of the measured values over a pixel.
The ESI uses the linear display voltage after the envelope detection. The linear samples are squared, summed and the sum is divided through the number of samples (= mean of squares). With the logarithmic display, the logarithm of the sum of squares is taken. With the linear display the mean of the squares is displayed directly. Each pixel represents the total power of the measured values assigned to the pixel.
The rms detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or pulse signal). There is no need for the various waveform correction factors which are required when other detectors are used for the power measurement.

Average detector

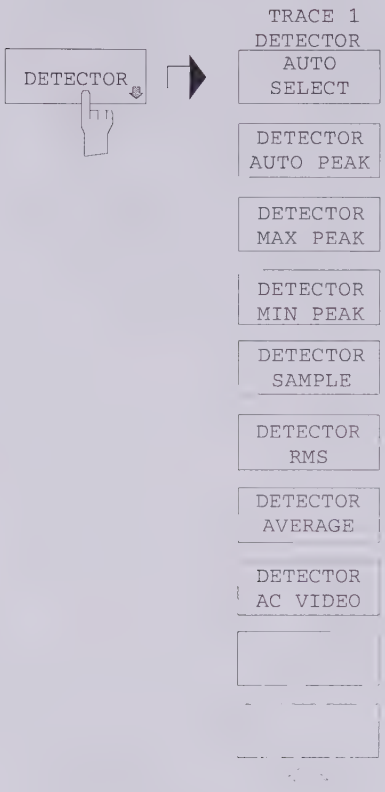
The average detector averages the measured values over a pixel.
The ESI uses the linear display voltage after envelope detection. The linear samples are summed and the sum is divided by the number of measurement samples (= linear average). With the logarithmic display, the logarithm of the average is taken. With the linear display the average is displayed directly. Each pixel therefore represents the average of the measured values assigned the pixel.
The average detector gives the true average of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or pulse signal).

AC video detector
(with option ESI-B1 only)2

The AC video detector forms the difference (max peak – min peak) of measurement results within a pixel or a result.
For this purpose ESI uses the linear display voltage after envelope detection. The max peak detector and the min peak detector determine the maximum and minimum levels within a shown measurement point and display it as a common measurement result. For logarithmic representation, the logarithm of the difference is formed. For linear representation, the difference itself is shown. This means that for analyzer operation each pixel corresponds to the AC value of the measurement results combined in the pixel. In receiver operation, on the other hand, the AC value determined during the measurement time is shown.
Irrespective of the signal form (CW carrier, modulated carrier, white noise of pulsed signal), the AC video detector always supplies the AC component of the signal.
If during a frequency sweep the dwell time on a certain frequency point is not sufficient, this may lead to incorrect results being displayed.

Note: *During a sweep, the ESI switches the first oscillator frequency in steps which are smaller than approximately 1/10 of the bandwidth. This guarantees that the level of a signal is correctly measured. For narrow bandwidths and wide spans, a very large number of measurement values are generated. The number of frequency steps is, however, always a multiple of 500 (= number of displayable points). In the sampling mode, only every n^{th} value is displayed. The quantity n depends upon the number of measurement values, i.e on the span, resolution bandwidth and the measurement rate.*

TRACE 1-DETECTOR submenu

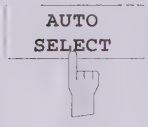


The *DETECTOR* softkey opens a submenu to select the detector.

Softkey *AC VIDEO* is available only if the instrument is equipped with the linear video output (option ESI-B1)

The detector may be independently selected for each trace. Mode *AUTO SELECT* sets the best suitable detector for each trace display mode (Clear Write, Max Hold oder Min Hold).

Only one of the softkeys for the detectors can be activated at any one time.



The *AUTO SELECT* softkey (= default) selects the optimum detector for the selected trace display mode (clear write, max hold, min hold).

Trace-mode	Detector
Clear/Write	Autopeak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

IEC/IEEE-bus command

```
:[SENSe<1|2>:]DETector<1..4>:AUTO ON|OFF
```

The *DETECTOR AUTOPEAK* softkey selects the autopeak detector.

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1..4> APEak`

The *DETECTOR MAX PEAK* softkey selects the max peak detector. It is recommended for pulse-like signals.

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1..4> POSitive`

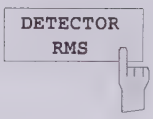
The *DETECTOR MIN PEAK* softkey selects the min peak detector. Weak sinewave signals can be brought out clearly against noise by using this detector. For a composite signal made up of sinewaves and pulse-like-like signals the pulse signals are suppressed.

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1..4> NEGative`

The *DETECTOR SAMPLE* softkey selects the sample detector.

It is used for measuring uncorrelated signals such as noise. The power can be determined by means of fixed correction factors for evaluation and the log amplifier.

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1...4> SAMPle`



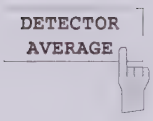
The *DETECTOR RMS* softkey activates the rms detector.

The rms detector gives the true power of the signal irrespective of the waveform. The mean of the squares of all level samples is formed as a pixel is swept. The sweep time, therefore, determines the number of values averaged and, with increasing sweep time, better averaging is obtained. The rms detector is therefore an alternative to averaging over several sweeps (see *TRACE AVERAGE*).

In the time domain (SPAN = 0), the rms detector is only available for sweep times ■ 5 ms. Moreover, the combination of the rms detector with the pretrigger function and the gaped sweep function is not permissible.

The video bandwidth has to be set to at least 10 times the resolution bandwidth (RBW) so that the rms value of the signal is not invalidated by video filtering.

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1...4> RMS`



The *DETECTOR AVERAGE* softkey activates the average detector.

In contrast to the rms detector, the average detector supplies the straight average of all the level sampleds as a pixel is swept over.

The same restrictions as those of the rms detector apply (see above).

IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1...4> AVERage`

The *DETECTOR AC VIDEO* softkey activates the *AC VIDEO* detector.

Irrespective of the signal form, the *AC VIDEO* detector always supplies the AC component of the signal. For this purpose the difference is formed of all maximum and minimum level values collected during the runtime of the pixel / the set measurement time. The sweep / measurement time therefore determines the number of values to be considered, so the AC component is determined more accurately with increasing sweep / measurement time. The *AC VIDEO* detector can thus be used as an alternative for the detection of modulated signals.

The softkey is available only if the instrument is equipped with the linear video output (option ESI-B1).

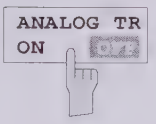
IEC/IEEE-bus command `:[SENSe<1|2>:]DETector<1..4> ACVideo`

Quasi Analog Display

Normally, when measured values are displayed they are joined together with line segments to form a trace which is deleted and redrawn after each sweep. When analog measurements are performed, the persistence of the screen makes it possible to assess the signal's frequency of occurrence. Frequently occurring events appear brighter on the screen than events that occur less frequently.

The *ANALOG TRACE* function simulates an analog display.
In this case, a measured value is represented by a single pixel on the screen. After the trace has been explicitly cleared with *CLEAR / WRITE, this pixel is reset.* As the trace is build up from several sweeps, the frequency distribution is, in effect, indicated by the varying brightness of the trace.

TRACE 1 side menu



The ANALOG TR ON/OFF switches the quasi-analog display mode on and off for the selected trace

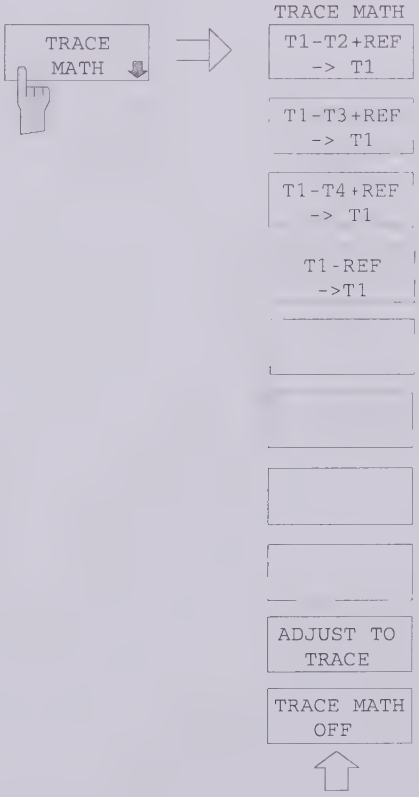
The measurement is always made with the selected detector.

IEC/IEEE-bus command

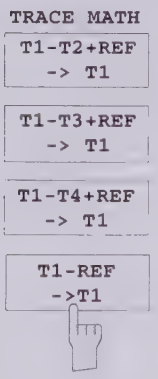
```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:MODE:ANALog ON | OFF
```

Mathematical Functions for Traces

TRACE 1-TRACE MATH submenu:



The *TRACE MATH* softkey opens a submenu in which a differential curve for the selected trace is calculated.



The *T1-T2+REF, T1-T3+REF, T1-T3+REF* and *T1-REF* softkeys subtract the traces and add the set level to the difference. If the reference line is switched on (see key D LINES), the level value of the reference line instead of the reference level is added to the difference. Thus, the differential curve can be positioned anywhere on the screen by shifting the reference line. The difference of the two traces with respect to the reference line is displayed.

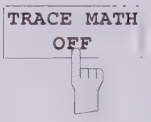
The *T1-REF* softkey subtracts the level of the reference line from the trace level.

To indicate that the trace is a difference trace, a enhancement label is displayed at the right margin of the measurement value diagram (1-2, 1-3, 1-4, 1-R). In *TRACE 1* main menu, the *TRACE MATH* softkey is on a coloured background to show that the function is being used.

***Important**: For a display with two measurement windows, not all combinations are allowed if the sweep data for screen A and screen B are not the same. Only the traces allowed in the screen can be combined (in screen A, only trace 1 with trace 3; in screen B, only trace 2 with trace 4).*

IEC/IEEE-bus command

```
:CALCulate<1|2>:MATH<1..4>:STATe ON
:CALCulate<1|2>:MATH<1..4>[:EXPRession][:DEFine] <expr>
```



The *TRACE MATH OFF* softkey switches the math function off. The softkey is only available when a conversion function is enabled.

IEC/IEEE-bus command `:CALCulate<1|2>:MATH<1...4>:STATe OFF`

The *ADJUST TO TRACE* softkey restores the original instrument settings when the corresponding trace is set to *VIEW* and the current instrument settings are different than those of the trace data.

If a trace is frozen with *VIEW*, changes in the instrument settings can be made without influencing the trace. An asterisk(*) at the edge of the display screen indicates that the current instrument settings are different than those in effect when the trace was recorded. In this case, the *ADJUST TO TRACE* softkey is presented with which the original instrument setting can be restored.

IEC/IEEE-bus command `--`

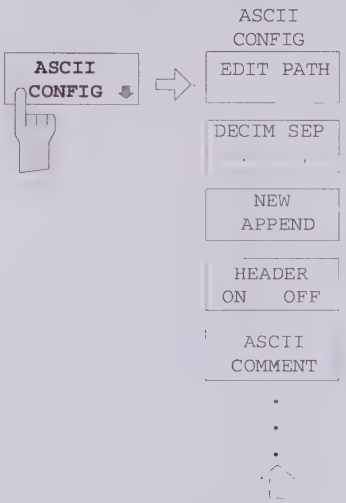
Trace Export

TRACE 1 menu:

The *ASCII EXPORT* softkey stores the active trace in a file with ASCII format. Upon pressing the *ASCII EXPORT* softkey, a file name can be entered. The default name is TRACE.DAT. Then the measured data of the trace are stored. The function can be configured in the *ASCII CONFIG* submenu.

IEC/IEEE-bus command `:MMEMory:STORe:TRACe 1..4,<path>`

TRACE 1 menu:



The *ASCII CONFIG* softkey calls a submenu for various settings for the *TRACE ASCII EXPORT* function.

The *EDIT PATH* softkey defines the directory in which the file is to be stored.

IEC/IEEE-bus command `--`

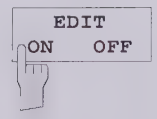
The *DECIM SEP* softkey selects the decimal separator for the ASCII file. The choice is '.' (decimal point) or ',' (comma).
This means that the decimal separator used in various language versions of evaluation programs (e.g. MS-Excel) can be selected so that the packages are supported. .

IEC/IEEE-bus command
`:FORMat:DEXPort:DSEParator POINt|COMMA`

The *APPEND NEW* softkey defines whether output data are to be written to an existing file or a new file.

- With *APPEND,* the data are added to an existing file.
- With *NEW,* either a new file is generated or an existing file is overwritten by storage of the data.

IEC/IEEE-bus command `:FORMat:DEXPort:APPend ON | OFF`



The *HEADER ON/OFF* softkey defines whether important instrument settings should be stored at the beginning of the file.

IEC/IEEE-bus command `:FORMat:DEXPort:HEADer ON | OFF`

The *ASCII COMMENT* softkey activates the entry of commentary concerning the current ASCII data set. A total of 60 characters are available for this purpose.

IEC\IEEE bus command `:FORMat:DEXPort:COMMent 'string'`

Structure of the ASCII file:

The file consists of the header containing important scaling parameters and a data section containing the trace data. The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit

The data section starts with the keyword " Trace <n> " (<n> = number of stored trace), followed by the measured data in one or several columns (depending on measurement) which are also separated by a semicolon.
This format can be read in from spreadsheet calculation programs, eg MS-Excel. It is necessary to define ';' as a separator.

	Content of file	Description
File header	Type;ESI7;	Instrument model
	Version;2.10;	Firmware version
	Date;01.Jul 1999;	Date record storage date
	Mode;Spectrum;	Instrument operating mode
	Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0,
	Center Freq;55000;Hz	Center frequency
	Span;90000;Hz	Frequency range (0 Hz for zero span)
	Freq Offset;0;Hz	Frequency offset
	x-Axis;LIN;	Scaling of x axis linear (LIN) or logarithmic (LOG)
	y-Axis;LOG;	Scaling of y axis linear (LIN) or logarithmic (LOG)
	Ref.Level;-30;dBm	Reference level
	Level Offset;0;dB	Level offset
	Max Level	Maximium level
	Level Range;100;dB	Display range in y direction. Unit: dB for x axis LOG, % for x axis LIN
	RF Att;20;dB	Input attenuation
	RBW;100000;Hz	Resolution bandwidth
	VBW;30000;Hz	Video bandwidth
	SWT;0.005;s	Sweep time
	Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
	Detector;SAMPLE;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE, RMS,SAMPLE
	Sweep Count;20;	Number of sweeps set
Data section of the file	Trace 1:;;	Selected trace
	x-Unit;Hz;	Unit of x values: Hz for span > 0; s for span = 0; dBm/dB for statistics measurements
	y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit for y axis LOG or % for y axis LIN
	Values;500;	Number of measurement points
	10000;-10.3;-15.7 10180;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2> <y2> being available only with AUTOPEAK detector and containing in this case the smaller of the two measured values for a measurement point.

Example:

```
Type;ESI7;
Version;2.10;
Date;20.Sep 1999;
Mode;Spectrum;
Start;0.000000;Hz
Stop;3500000000.000000;Hz
Center Freq;1750000000.000000;Hz
Span;3500000000.000000;Hz
Freq Offset;0.000000;Hz
x-Axis;LIN;
y-Axis;LOG;
Level Range;100.000000;dB
Ref. Level;-20.000000;dBm
Level Offset;0.000000;dBm
Max. Level;-20.000000;dBm
RF Att;10.000000;dB
RBW;3000000.000000;Hz
VBW;3000000.000000;Hz
SWT;0.005000;s
Trace Mode;CLR/WRITE;
Detector;AUTOPEAK;
Sweep Count;0;
TRACE 1:
x-Unit;Hz;
y-Unit;dBm;
Values;500;
0.000000;-44.465958;-60.190887
7014028.056112;-49.233063;-81.451668
14028056.112224;-75.692101;-101.811501
21042084.168337;-75.147057;-101.229843
28056112.224449;-75.114517;-95.358429
35070140.280561;-71.769005;-100.755981
...
```

If all traces are to be stored in one file with the header information stored only once, the following procedure is recommended:

[TRACE 1] [MENU ▬][ASCII CONFIG]	
[ASCII CONFIG] [NEW]	Generate new file
[ASCII CONFIG] [HEADER ON]	with header
[TRACE 1] [MENU ▬][ASCII EXPORT]	Store trace 1 with header
[TRACE 2] [MENU ▬][ASCII CONFIG]	
[ASCII CONFIG] [APPEND]	Append to end of file
[ASCII CONFIG] [HEADER OFF]	without header
[TRACE 2] [MENU ▬][ASCII EXPORT]	Write trace 2 to file
[TRACE 3] [MENU ▬][ASCII EXPORT]	Write trace 3 to file
[TRACE 4] [MENU ▬][ASCII EXPORT]	Write trace 4 to file

Sweep Control – *SWEEP Key Group*

Using the *SWEEP* key group, the parameters are entered which determine the sweep characteristics. These are the coupled functions resolution bandwidth, video bandwidth and sweep time (*COUPLING* key), the trigger used for starting the sweep (*TRIGGER* key) and the type of sweep (*SWEEP* key).

Coupled Settings – *COUPLING* Key

The *COUPLING* key calls a menu for entering the sweep parameters resolution bandwidth *(RBW)*, video bandwidth *(VBW)* and sweep time *(SWT)*. The parameters may be coupled as a function of the span, coupled to each other or set by the user. When working with a split screen display, the settings always refer to the active window.

The ESI offers the resolution bandwidths 1 Hz to 10 MHz in 1, 2, 3, 5steps:

The ESI resolution bandwidths up to 1 kHz have been implemented using digital filters with Gaussian characteristics. They behave like analog filters. The 1-kHz filter has been implemented both as a decoupled quartz filter and as a digital filter. One of the two filter types can be selected. The bandwidths from 2 kHz to 30 kHz have been implemented using decoupled quartz filters, the bandwidths between 50 kHz and 5 MHz using decoupled LC filters. These filters consist of 5 circuits, their shape factor is < 12, typ. 9.5.

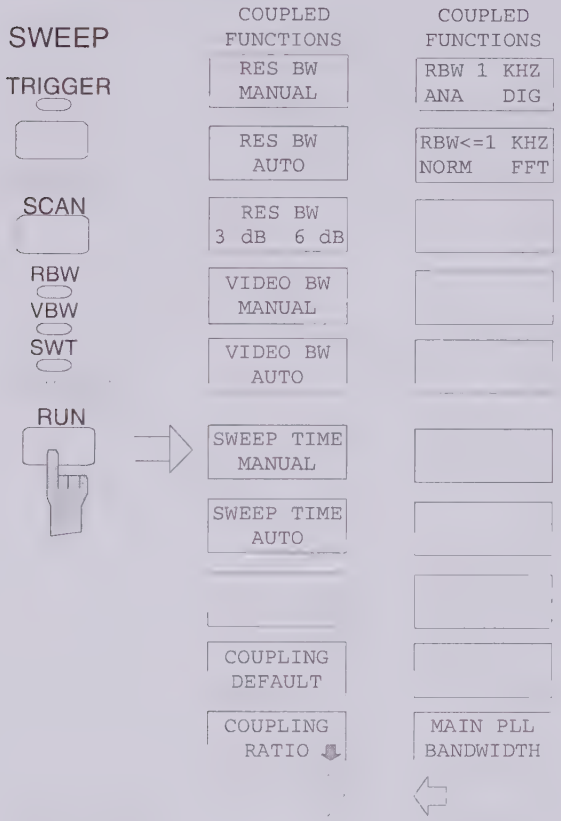
The 10-MHz filter is a critically coupled LC filter.

For bandwidths up to about 1 kHz, the FFT-algorithm, as compared to other filter methods with identical settings, offers clear advantages with respect to the measurement time. The reason is that with analog filters the sweep time required for a particular span is proportional to (Span/RBW^2). The FFT-algorithm reduces that time to a value proportional to (Span/RBW).

FFT-filters are provided for bandwiths between 1 Hz and 1kHz as an alternative to the analog filters.
The video bandwidths are available in 1/2/3/5 steps between 1 Hz and 10 MHz. They can be set independent of the resolution bandwidth. Video bandwidths between 1 Hz and 10 kHz are available for resolution bandwidths up to 1 kHz and video bandwidths between 1 Hz and 10 MHz are available for resolution bandwidths greater than or equal to 2 kHz. The video filters are used to smooth the traces. Small video bandwidths in relation to the resolution bandwidth average out noise peaks pulse-like signals such that only the average value of the signals is displayed. A large video bandwidth in relation to the resolution bandwidth is therefore recommended when measuring pulsed signals (VBW ■ 10 x RBW) so that the amplitude of pulses can be measured correctly.

Setting and Coupling the Coupling Resolution, Video Bandwidth and Sweep Time

SWEEP COUPLING menu



The *COUPLING* key calls a menu and a supplementary menu for setting the resolution bandwidth, video bandwidth, sweep time and their coupled states.

The *AUTO* softkeys are used to couple the functions. The coupling ratios are selected in the *COUPLING RATIO* sub-menu.

The *MANUAL* softkeys request that the respective parameter be entered in the entry window. This parameter is not coupled to the other parameters.

The *RES BW AUTO* softkey couples the resolution bandwidth to the selected span. Changing the span causes automatic compensation of the resolution bandwidth.

Automatic coupling of the resolution bandwidth to span is always recommended when, for the measurement problem on hand, a favorable setting of the resolution bandwidth in relation to the selected span is desired.
The coupling ratio is set in the *COUPLING RATIO* sub-menu.
The coupling is indicated by illumination of the softkey and the active *RBW* LED.

The *RES BW AUTO* softkey is only available in the frequency domain (span > 0 Hz). The softkey is blanked in the time domain.

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth[:RESolution]:AUTO ON`

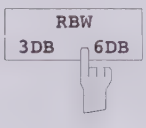
The *RES BW MANUAL* softkey activates the manual entry mode for the resolution bandwidth.
The lower limit of the bandwidth is 1 Hz.

For numerical inputs, the values are always rounded to the next valid bandwidth. For rollkey or the UP/DOWN key entries, the bandwidth is adjusted in steps either upwards or downwards.

For manual input of the resolution bandwidth (coupling off), the *RBW* LED on the front panel remains off.

IEC/IEEE-bus commands

```
:[SENSe<1|2>:]BWIDth[:RESolution]:AUTO OFF
:[SENSe<1|2>:]BWIDth[:RESolution] 1MHz
```



The *RES BW 3DB/6DB* softkey switches between 3 dB and 6 dB bandwidths of the resolution filters.

3-dB bandwidths:	1 Hz to 10 MHz i available in steps of 1/2/3/5.
6-dB bandwidths:	10 Hz, 100 Hz, 200 Hz, 1 KHz, 9 kHz, 10 kHz, 100 kHz, 120 kHz, 1 MHz, 10 MHz.

The 9 kHz and 120 kHz CISPR bandwidths are only available as 6 dB bandwidths.

Some of the marker functions are not available when using the 6 dB bandwidths.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]BWIDth[:RESolution]:FILTer 3|6
```

The *VIDEO BW AUTO* softkey couples the video bandwidth of the ESI to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

The coupling of the video bandwidth is always recommended when the maximum sweep time for a selected resolution bandwidth is to be obtained. Small video bandwidths require longer sweep times due to the longer settling time. Large bandwidths reduce the signal/noise ratio.

The coupling ratio is set in the *COUPLING RATIO* menu.

The coupling is indicated by illumination of the softkey and the lighted *VBW* LED on the front panel.

The coupling of the video bandwidth to the resolution filter is also permitted for display in the time domain (span = 0).

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth:VIDeo:AUTO ON`

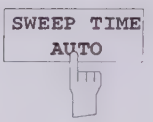
The *VIDEO BW MANUAL* softkey activates the manual entry for the video bandwidth.

The video bandwidth can be selected in 1/2/3/5 steps between 1 Hz and 10 MHz. For bandwidths up to 1 kHz, the maximum video bandwidth is 10 kHz, for larger resolution bandwidths, there is no restriction to the video bandwidth.

For numerical entries, rounding is made to the next valid bandwidth. For rollkey or UP/DOWN entries, the bandwidth is adjusted in steps either downwards or upwards.

For manual input, the video bandwidth (coupling disabled) *VBW* LED on the front panel is turned off.

IEC/IEEE-bus commands
```
:[SENSe<1|2>:]BWIDth:VIDeo:AUTO OFF
:[SENSe<1|2>:]BWIDth:VIDeo 10kHz
```

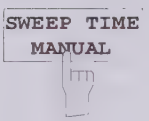


The *SWEEP TIME AUTO* softkey couples the sweep time to the span, video bandwidth (VBW) and resolution bandwidth (RBW). The sweep time is automatically adjusted whenever the span, resolution bandwidth or video bandwidth are changed. The ESI always selects the shortest sweep time which will not lead to spurious measurements.

The coupling is indicated by illumination of the softkey and turning on the *SWT* LED.

The softkey is only available in the frequency domain (span > 0 Hz). The softkey is blanked in the time domain.

IEC/IEEE-bus command
```
:[SENSe<1|2>:]SWEep:TIME:AUTO ON
```



The *SWEEP TIME MANUAL* softkey activates the manual entry for the sweep time. At the same time, the coupling of the sweep is cancelled and the *SWT* LED is turned off. Other couplings (*VIDEO BW, RES BW*) remain in effect.

In the frequency domain (span > 0 Hz) and for resolution bandwidths ■ 1 kHz, sweep times from 5 ms through 16000 s are allowed in steps that are at most 5% of the sweep time. The digital resolution filters from 10 Hz to 1 kHz allow a minimum sweep time of 20 ms.

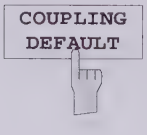
If an FFT-filter is used the sweep time is fixed by the display range and resolution bandwidth selected and therefore can not be changed.

In the time domain (span = 0 Hz), the sweep time range is 1 µs to 2500 s, selectable in steps that are at most 5% of the sweep time.

Numerical entries are rounded to the next valid sweep time. For rollkey or UP/DOWN entries, the sweep time is adjusted in steps either downwards or upwards.

If the selected sweep time is too small for the selected span and bandwidth, measurement errors will occur. This happens because the available settling time for the resolution filter or the video filter is too short. The ESI, therefore, outputs *UNCAL* on the display

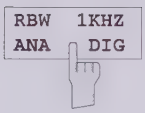
IEC/IEEE-bus commands
```
:[SENSe<1|2>:]SWEep:TIME:AUTO OFF
:[SENSe<1|2>:]SWEep:TIME 10s
```



The *COUPLING DEFAULT* softkey sets all coupled functions to *AUTO*. The *RBW / VBW* ratio is also set to *SINE [1]* and the *SPAN/RBW* ratio is set to 50 in the *COUPLING RATIO* submenu (default setting, *COUPLING RATIO* softkey not illuminated).
The relevant softkeys are then illuminated.

IEC/IEEE-bus commands

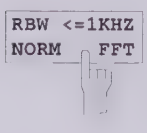
```
:[SENSe<1|2>:]BWIDth[:RESolution]:AUTO ON;
:[SENSe<1|2>:]BWIDth:VIDeo:AUTO ON;
:[SENSe<1|2>:]SWEep:TIME:AUTO ON
```



The *RBW 1kHz ANA/DIG* softkey enables either the analog quartz filter (ANA) or the digital filter (DIG) for the instruments's resolution bandwidth of 1 kHz. In the default setting, the instrument uses the analog IF filter for the 1-kHz bandwidth.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]BWIDth:MODE ANALog | DIGital
```



The *RBW<=1kHz NORM/FFT* softkey toggles between fixed filter and FFT-filter.

NORM For resolution bandwidths up to 1 kHz fixed IF-filters are used.

FFT An FFT is performed. The filtered IF-signal is digitalized by the 3-kHz resolution filters and then transformed into a spectrum by FFT. The transformation range is equal to the selected span but covers 4 kHz at maximum. If the span is larger than the transformation range, serveral subsequent transformations are performed, the results are combined to form a complete spectrum. The frequency response of the 3-kHz preselection filter is compensated for so that the amplitude response within the transformation range is offset. A flattop window serves as a window in the time domain so that a high amplitude precision with good selectivity is obtained.

Span:
- minimum display range: 50■ resolution bandwidth selected
- maximum display range:
  Resolution bwidths > 20 Hz: 2 MHz (500 FFT-transf./sweep at maximum)
  Resolution bwidths < 20Hz: Reduction to 125 kHz at 1 Hz resolution bandwidth

Level display range: 100 dB at max. With greater spans, the trace is limited to 100 dB below the reference level.

Sweep time: fixed by the bandwidth selected and the span.
(reason: an FFT-filter represents a block transformation). The sweep time can not be changed (softkey inactive).

Detector All settings of the sample detector are fixed, no other detector can be selected (softkeys inactive)

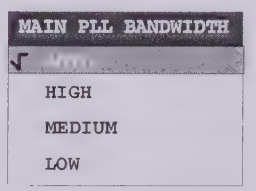
Video bandwidth not defined for FFT-transf. therefore it can not be set (softkeys inactive).

Compared to fixed filters, FFT-filters cut sweep times considerably. For a display range of 50 kHz and a resolution bandwith of 100 Hz, e. g., the sweep time is reduced from 25 s to 520 ms. FFT-filters are ideal for stationary signals (sinusoidal signals or signals that are continuously modulated in time). For burst signals (TDMA) or pulses, fixed filters should be preferred. The FFT is a block transformation so that the result depends on the time relation between the dataset to be transformed and the burst or pulse signal. A 'gated sweep' measurement for TDMA signals is therefore not provided if FFT-filters are used.

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth:MODE:FFT ON|OFF`

MAIN PLL BANDWIDTH

The *MAIN PLL BANDWIDTH* softkey opens a selection window for setting the PLL control bandwidth.



The first local oscillator is synchronized with the PLL control bandwidth. The control bandwidth determines the characteristic of the phase noise. A medium or high control bandwidth improves the phase noise for frequency differences smaller than 10 kHz to the carrier, whereas a low control bandwidth improves the phase noise for frequency differences larger than 100 kHz to the carrier. If the control bandwidth is set unfavorably, the phase noise is deteriorated.

The PLL bandwidth is set in the AUTO mode depending on the RBW and SPAN according to the following tables:

MAIN PLL BANDWIDTH	SPAN ■ 100 kHz and RBW < 3kHz	SPAN > 100 kHz or RBW ■ 3kHz
HIGH	X	
MEDIUM		X
LOW		

The setting is chosen such that the phase noise for small spans with small resolution bandwidth near the carrier is optimized.

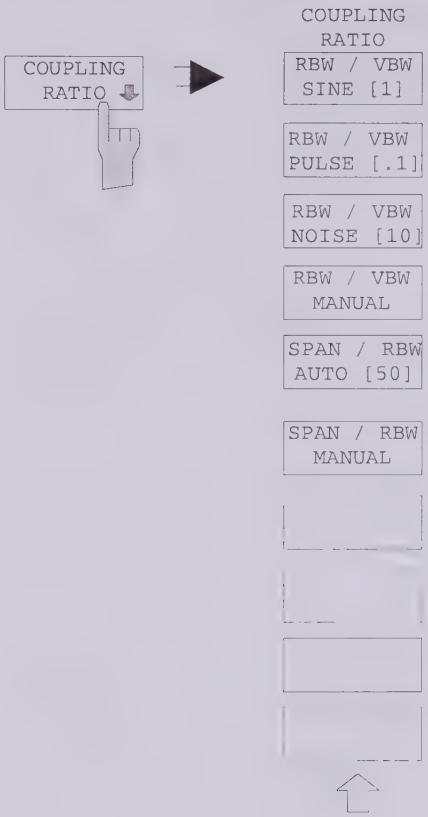
For measurements with small span but with a relatively large frequency difference to the carrier (>100kHz), the automatic bandwidth setting deteriorates the phase noise relative to the optimal setting. The *MAIN PLL BANDWIDTH* softkey allows to by-pass this automatic setting. Optimal settings are, as a function of the carrier difference @:

MAIN PLL BANDWIDTH	@ ■ 10 kHz	10 kHz < @ < 100 kHz	@ ■ 100 kHz
HIGH	X		
MEDIUM		X	
LOW			X

If a larger control bandwidth is needed due to the sweep velocity, the processor automatically increases the control bandwidth as far as necessary.

Sweep Coupling Ratio

SWEEP COUPLING-COUPLING RATIO submenu:

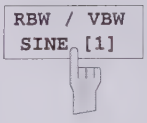

COUPLING RATIO
COUPLING RATIO
RBW / VBW SINE [1]
RBW / VBW PULSE [.1]
RBW / VBW NOISE [10]
RBW / VBW MANUAL
SPAN / RBW AUTO [50]
SPAN / RBW MANUAL

The *COUPLING RATIO* softkey opens a sub-menu in which the coupling ratio between resolution bandwidth, video bandwidth and the span can be defined.

These settings are effective only for the selected parameters in ...*AUTO* of the main menu.

The softkeys *RBW/VBW PULSE, RBW/VBW SINE, RBW/VBW NOISE, RBW/VBW MANUAL* are selection keys. Only one softkey can be enabled (illuminated) at any one time.

The same is valid for the softkeys *SPAN/RWB AUTO [50]* and *SPAN / RWB MANUAL.*



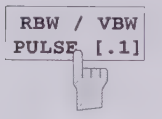
The *RBW / VBW SINE [1]* softkey always sets the video bandwidth equal to the resolution bandwidth.

This is the default setting for the coupling ratio resolution bandwidth to video bandwidth.

This coupling ratio is recommended when sine-wave signals are to be measured.

This setting is only effective for the *VBW AUTO* selection in the main menu.

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth:VIDeo:RATio SINe`



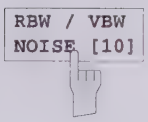
The *RBW / VBW PULSE* softkey sets the following coupling ratio:

video bandwidth = 10 x resolution bandwidth
or
video bandwidth = 10 MHz (= maximum video bandwidth).

This coupling ratio is recommended when the amplitude of pulsed signals is to be measured. The IF filter characteristics alone determine the pulse shape. No additional weighting is provided by the video filter.

This setting is only effective for the *VBW AUTO* selection in the main menu.

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth:VIDeo:RATio PULSe`



The *RBW / VBW NOISE* softkey sets the following coupling ratio:
video bandwidth = resolution bandwidth/10

At this coupling ratio, noise and pulsed signals are suppressed in the video section. For noise signals, the ESI displays the average value.

This softkey is disabled unless *VBW AUTO* is selected in the main menu.

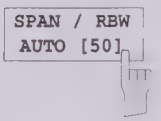
IEC/IEEE-bus command
`:[SENSe<1|2>:]BWIDth:VIDeo:RATio NOISe`

The *RBW / VBW MANUAL* softkey activates the entry of the coupling ratio for resolution bandwidth to video bandwidth.

The range for the RBW/VBW ratio is 0,001 to 1000.

This softkey is disabled unless *VBW AUTO* is selected in the main menu.

IEC/IEEE-bus command `:[SENSe<1|2>:]BWIDth:VIDeo:RATio 10`

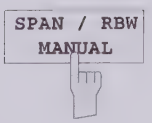


The *SPAN / RBW AUTO [50]* softkey sets the following coupling:
resolution bandwidth = span/50

This coupling corresponds to the default state.

This softkey is disabled unless *RBW AUTO* is selected in the main menu.

IEC/IEEE-bus command
`:[SENSe<1|2>:]BWIDth[:RESolution]:RATio 0.02`



The *SPAN / RBW MANUAL* softkey activates the entry for the coupling of resolution bandwidth and span.

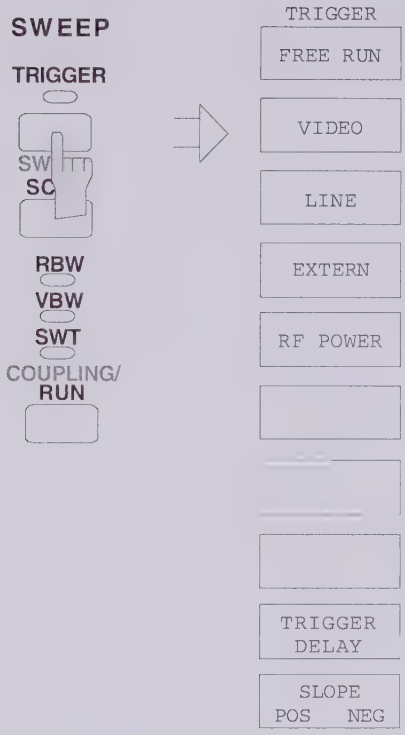
The range for the SPAN/RBW ratio is 1 to 10000.

This softkey is disabled unless *RBW AUTO* is selected in the main menu.

IEC/IEEE-bus command
`:[SENSe<1|2>:]BWIDth[:RESolution]:RATio 0.1`

Sweep Trigger – TRIGGER Key

SWEEP TRIGGER menu:



The *TRIGGER* key opens a menu for selecting the various trigger sources and the trigger polarity. The active trigger mode is indicated by illumination of the corresponding softkey.

For triggering modes in which the trigger threshold can be entered, the corresponding entry window is activated and, if appropriate, a horizontal trigger line is displayed.

The *FREE RUN, VIDEO, LINE, EXTERN* and *RF-POWER* softkeys are selection switches. Only one key can be enabled at any one time (illuminated). For sweep operations controlled by a gate signal, the *FREE RUN* setting is the only setting possible.

If triggering has taken place, the trigger LED is turned on at the beginning of the sweep and then turned off at the end of sweep.

To indicate that the ESI is set for triggering (= not free run), the enhancement label **TRG** is shown on the display. If two measurement windows are displayed, TRG appears next to the window which is configured for triggering.

The *FREE RUN* softkey activates the free-run sweep mode (default setting), i.e. the start of a sweep is not explicitly triggered. Once a measurement is completed, another is started immediately.

IIEC/IEEE-bus command

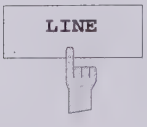
```
:TRIGger<1|2>[:SEQuence]:SOURce  IMMediate
```

The *VIDEO* softkey activates triggering by the displayed voltage.

For the video triggering mode, a level line showing the trigger threshold is displayed. Using the level line, the threshold can be adjusted with the roll-key or the UP/DOWN keys.

IEC/IEEE-bus commands

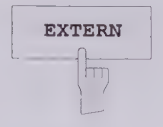
```
:TRIGger<1|2>[:SEQuence]:SOURce  VIDeo
:TRIGger<1|2>[:SEQuence]:LEVel:VIDeo 50PCT
```



The *LINE* softkey activates triggering derived from the mains (line) frequency. The power supply generates a trigger pulse at the line frequency which is used to trigger a new sweep.

IEC/IEEE-bus commands

```
:TRIGger<1|2>[:SEQuence]:SOURce LINE
```



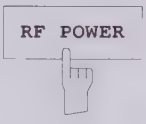
The *EXTERN* softkey activates triggering by an external voltage (-5V...+5V) at the input connector *EXT TRIGGER/GATE* on the rear panel.

The trigger threshold can be set in an entry window within a range of -5V...+5V.

External triggering in the sweep mode "gated sweep" (*SWEEP SWEEP-GATE ON)* is not possible, because the *EXT TRIG/GATE* connector is used to control the sweep. The softkey is not illuminated in these modes.

IEC/IEEE-bus commands

```
:TRIGger<1|2>[:SEQuence]:SOURce EXTernal
:TRIGger<1|2>[:SEQuence]:LEVel 2.5V
```



The *RF POWER* softkey activates triggering of the measurement by signals which are outside the measurement channel.

The ESI uses a level detector at the intermediate frequency. The detector threshold is approximately -20 dBm at the input mixer. This means that the actual trigger level at the RF input is approx. -20 dBm plus the set RF attenuation.

The bandwidth at the intermediate frequency is approximately 160 MHz. Triggering takes place when the trigger threshold is exceeded within a 100 MHz band about the selected frequency. Therefore, the measurement of noise emissions, e.g., for pulsed carriers, is possible. The carrier itself is suppressed via the selected resolution filter.

IEC/IEEE-bus command

```
:TRIGger<1|2>[:SEQuence]:SOURce RFPower
```

The *TRIGGER DELAY* softkey activates the entry window for delay time or a pretrigger.

The triggering is delayed or advanced relative to the trigger signal by the entered delay time. The delay time can be set in the range from -100 s to 100 s (default = 0 s).

Note: *A negative delay time (pretrigger) can be set in the time domain (SPAN < 0 Hz) only. The maximum range and the maximum resolution of the pretrigger is limited by the set sweep time:*
max. range = - 499/500 x sweep time
max. resolution = sweep time/500.
Pretriggering is not possible when the rms or the average detector is activated.

IEC/IEEE-bus command

```
:TRIGger<1|2>[:SEQuence]:HOLDoff 500us
```

The *SLOPE POS/NEG* softkey selects the trigger slope.

The sweep starts after a positive or negative trigger signal edge. The selected setting is illuminated.

The selection is valid for all trigger modes with the exception of *FREE RUN.*

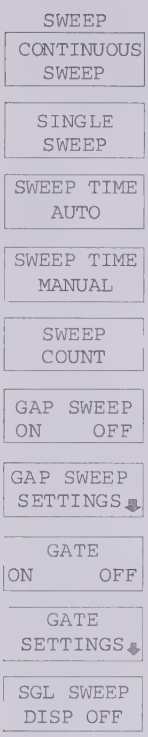
The default mode is *SLOPE POS.*

IEC/IEEE-bus command

```
:TRIGger<1|2>[:SEQuence]:SLOPe POS |NEG
```

Sweep Setup – SWEEP Key

SWEEP SWEEP menu:



The *SWEEP* key calls a menu in which the type of sweep (sweep mode) is determined. In split screen mode, the entries are valid only for the active measurement window.

In the menu, continuous or single sweep mode, gap-sweep settings or the external gate function can be selected.

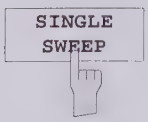
The *CONTINUOUS SWEEP* and *SINGLE SWEEP* softkeys are selection switches. Only one softkey can be active at any one time.

The *CONTINUOUS SWEEP* softkey sets the continuous sweep mode. This means, that the sweep takes place continuously according to the trigger conditions.

In the case of split screen display with different settings in each measurement window, screen A is swept first and then screen B. After pressing the softkey, the sweep is initialized and restarted.

CONTINUOUS SWEEP is the default setting of the ESI.

IEC/IEEE-bus commands
```
:INITiate<1|2>:CONTinuous ON;
:INITiate
```



The *SINGLE SWEEP* softkey starts a series of n sweeps according to the triggering definition. The number of sweeps, n, is determined by the *SWEEP COUNT* softkey.

In split screen display mode, the spans of each window are swept sequentially. If a displayed curve is averaged, the span is swept n times (n = sweep count). For n = 0, a single sweep takes place.

To indicate that the ESI is set for single sweep, the enhancment label **SGL** is shown on the display.

IEC/IEEE-bus commands
```
:INITiate<1|2>:CONTinuous OFF;
:INITiate
```

SWEEPTIME AUTO

SWEEPTIME MANUAL

The *SWEEPTIME AUTO* and *SWEEPTIME MANUAL* softkeys activate the automatic or manual selection of the sweep time. These functions are identical to the entries in the *COUPLING* menu (see section "Setting and Coupling the Coupling Resolution, Video Bandwidth and Sweep Time").

IEC/IEEE-bus commands

```
:[SENSe<1|2>:]SWEep:TIME:AUTO ON | OFF
:[SENSe<1|2>:]SWEep:TIME 10s
```

SGL SWEEP DISP OFF

The *SGL SWEEP DISP OFF* softkey switches off the display during a single sweep. The trace is displayed when the sweep has been completed.

IEC/IEEE-bus commands

```
:INITiate<1|2>:DISPlay ON | OFF;
:INITiate
```

SWEEP COUNT

The *SWEEP COUNT* softkey activates the entry of the number of sweeps performed by the ESI after the start of a single sweep. If trace average, max hold or min hold is switched on, this also determines the number of averages or minimua/maxima that are taken.

Example:
[**TRACE1**: *MAX HOLD*]
[**SWEEP**: *SWEEP COUNT*: {10} **ENTER**]
[*SINGLE SWEEP*]

The ESI performs the max hold function over 10 sweeps.

The sweep count range is 0 through 32767. For sweep count = 0 or 1, a sweep is performed. For trace averaging *(AVERAGE)*, sweep count = 0 and continuous sweep, the ESI performs a sliding average over 10 sweeps in average mode. For sweep count = 1, no averaging takes place.

The default setting totals 10 sweeps.

Note: *The setting for the number of sweeps in the TRACE menu is equivalent to the setting in the SWEEP menu. In SINGLE SWEEP mode, the measurement is stopped after reaching the chosen number of sweeps.*

IEC/IEEE-bus command

```
:[SENSe<1|2>:]SWEep:COUNt 0
```

Gated Sweep

By using a gate in the sweep mode and stopping the measurement while the gate signal is inactive, the spectrum of pulsed carriers can be displayed without overlaid frequency components caused by switching. Similarly, the spectrum can also be examined when the carrier is inactive. The sweep can be controlled by an external gate or by the internal power trigger.

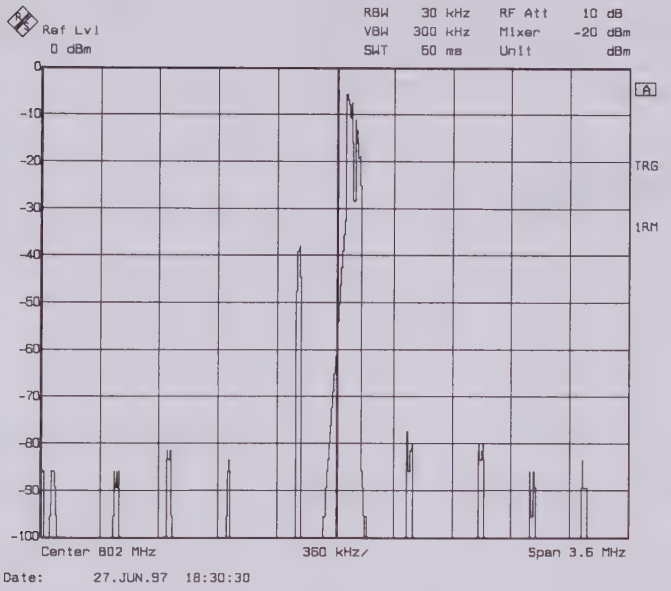


Fig. 4-13 Pulsed signal with GATE OFF

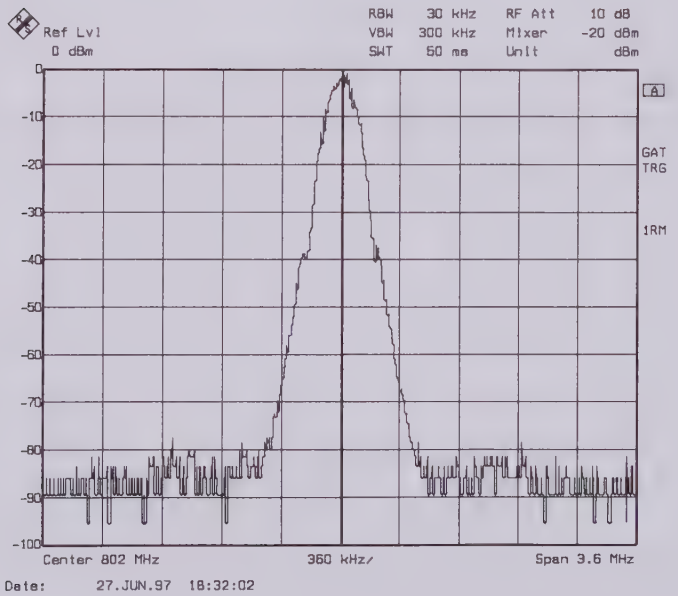
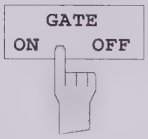


Fig 4-14 TDMA-signal with GATE ON

The 'gated sweep' mode is activated by the *GATE ON/OFF* softkey. The mode is set in the *GATE SETTINGS* sub-menu.

SWEEP SWEEP menu:



The *GATE ON / OFF* softkey switches the sweep mode with an internal or external gate on/off.

When *GATE ON* is selected, a signal applied to the rear panel connector *EXT TRIGGER/GATE* or the internal RF power detector controls the sweep of the analyzer. The sweep can be stopped and then continued. A switch from an edge triggered to a level triggered mode can also be made.

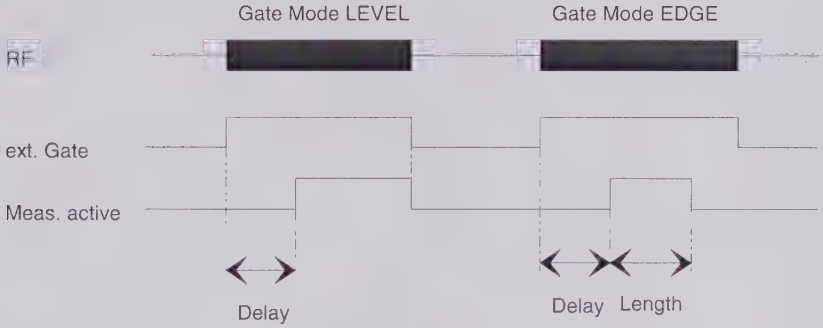


Fig. 4-15 Interaction of the parameters *GATE MODE*, *GATE DELAY* and *GATE LENGTH*

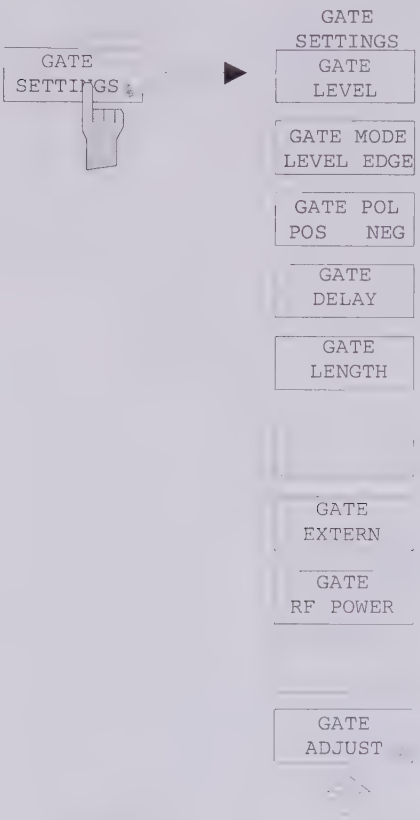
The softkey is only available in the frequency domain (span > 0).

GATE ON is only possible when the trigger mode is set to *FREE RUN* (*SWEEP TRIGGER* menu) .

To indicate that the ESI is set for sweep mode with external gate, the enhancement label GAT is displayed on the screen. GAT appears next to the window for which the gate is configured.

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:EGATe ON | OFF`

SWEEP SWEEP-GATE SETTINGS sub-menu:



In the *GATE SETTINGS* submenu, all settings are made which are necessary for 'gated sweep' operation.

On switching to the time domain, the *GATE DELAY* and *GATE LENGTH* times are represented by horizontal time lines which allow simple adjustment of the gate time.

The softkeys *GATE EXTERN* and *GATE RF POWER* provide alternative settings, only one of them can be active at one time.

The *GATE LEVEL* softkey activates the entry window for defining the threshold value of the external gate signal.

The threshold can be set between -5V and +5V.

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:EGATe:LEVel 3V`

The *GATE MODE LEVEL/EDGE* softkey selects the trigger mode. The sweep mode *GATE* can be operated either as level or as edge triggered.

For level triggering, the *GATE LENGTH* softkey is deactivated and can not be used.

IEC/IEEE-bus command

`:[SENSe<1|2>:]SWEep:EGATe:TYPE LEVel | EDGE`

The *GATE POL* softkey determines the polarity of the *GATE* control line.

If level triggering with *GATE POL POS* is set, the sweep is stopped when the gate signal is a logic ´ 0 ' (input signal < gate level) at the *EXT TRIGGER/GATE* input and then, when the gate signal goes to a logic ' 1 ', the sweep is continued after a delay time of *GATE DELAY*.

In the case of edge triggering, the sweep is continued on a ' 0 ' to ' 1' transition for the duration of *GATE LENGTH* after a delay (*GATE DELAY*) has elapsed.

IEC/IEEE-bus command

`:[SENSe<1|2>:]SWEep:EGATe:POLarity POS|NEG`

The *GATE DELAY* softkey activates the entry window for setting the delay time between the gate signal and the continuation of the sweep.

This may be usefull in allowing for a delay between the gate signal and the stabilization of an RF carrier.

Gate delay values can be selected between 1 µs and 100 s. The resolution is dependent upon the absolute value of the delay time:

Gate delay	Resolution
0 - 500 µs	1 µs
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

In the time domain, a time line is displayed separated from the trigger point by the gate delay time. This simplifies the adjustment of the necessary delay time.

The values for *GATE DELAY* and *GATE LENGTH* are displayed by two time lines. The duration of the active sweep for span > 0 (continuation of sweep: GATE DELAY line, stopping of sweep: GATE LENGTH line) is described by these two lines. A change in parameters causes a shift of the corresponding line position. After switching to span > 0, the selected times for the gated sweep are effective.

IEC-bus command `:[SENSe<1|2>:]SWEep:EGATe:HOLDoff 100us`

The *GATE LENGTH* softkey activates the entry window for defining the ESI sweep duration.

GATE LENGTH can be set to values between 1µs and 100 s. The resolution is dependent upon the absolute value of the gate length:

Gate length	Resolution
0 - 500 µs	1 µs
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

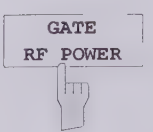
In the time domain *(ZERO SPAN)*, a time line is displayed separated from the *GATE DELAY* time by the *GATE LENGTH* time.

The softkey is only available for the *GATE MODE EDGE* setting (edge triggering). It is disabled for the *GATE MODE LEVEL* setting (level triggering).

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:EGATe:LENGth 10ms`

The *GATE EXTERN* softkey selects a signal applied to the *EXT TRIGGER/GATE* connector on the rear panel of the instrument as a gate source.

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:EGATe:SOURce EXT`

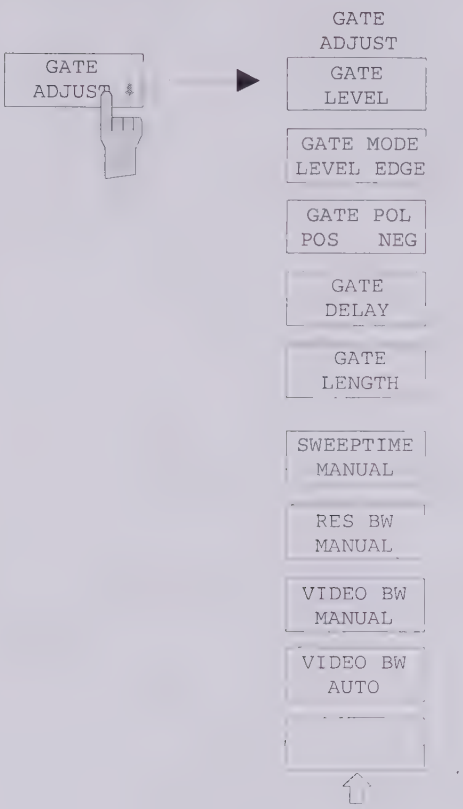


The *GATE RF POWER* softkey selects the internal RF power detector as a gate source.

IEC-bus command `:[SENSe<1|2>:]SWEep:EGATe:SOURce RFPower`

Setting the Gate Times

SWEEP SWEEP- GATE SETTINGS - GATE ADJUST submenu:



The *GATE ADJUST* softkey opens a submenu comprising all softkeys that are used to set the parameters relevant for the 'gated sweep' function.

On pressing this softkey, the display is switched to the time domain (zero span setting) so that all necessary times can be checked by means of cursor lines.

The values for Res BW, Video BW and sweep time are taken from the corresponding settings in the frequency domain.

To make sure that the times can be set correctly corresponding to the conditions in the frequency domain, the settings for the resolution bandwidth and the video bandwidth should not be changed.

The sweep time must be selected such that, e. g., a full burst is displayed. It usually differs from the sweep time in the frequency range.

Finally, *GATE DELAY* and *GATE LENGTH* can be used to set the times in such a way that the desired section in the spectral range is covered.

On quitting the submenu, the original settings in the frequency range are restored so that the measurement can be directly performed with the required parameters.

Measurement example:

The modulation spectrum of a GSM or PCS1900 signal to be measured using the 'gated sweep' function. The signal is generated by the test sender SME03. Its RF-output is directly connected to the RF input of the ESI.

Settings on the SME03:

FREQ:	802 MHz
Level:	0 dBm: Return
Digital Mod:	Select: GMSK: Select
Source:	Select: PRBS: Select: Return
Level Attenuation:	Select: 60 dB: Return

The SME03 provides a GMSK-modulated TDMA-signal (GSM)

Operation steps on the ESI:

[PRESET]	
[MODE]	
[▮]	*ANALYZER*
[CENTER:	{802} **MHz]**
[SPAN	{3.6} **MHz]**
[REF LVL:	{0} **dBm**: *RF ATTEN MANUAL*: {10} **dB]**
[COUPLING:	*RES BW MANUAL*: {30} **kHz]**
[TRACE 1:	*DETECTOR*: *RMS]*
[SWEEP:	*SWEEPTIME MANUAL*: {50} **ms**;
	GATE ON
	GATE SETTINGS: *GATE MODE EDGE: GATE POL POS: GATE RF POWER*
	GATE ADJUST: *SWEEPTIME MANUAL* {1} **ms**: *GATE DELAY* {300} **µs**: *GATE LENGTH*: {250} **µs]**

Note: ***[KEY]*** *Menu called by the KEY. All indications inside the bracket refer to this menu.*
{Number} *Numeric value to be entered for the corresponding parameter*
SOFTKEY *Softkey used to select a parameter or enter a value.*

The following figure shows the screen display for gate parameter setting: The vertical lines for gate delay (GL) and gate length (GL) can be adapted to the burst signal by entering numbers or with the rollkey.

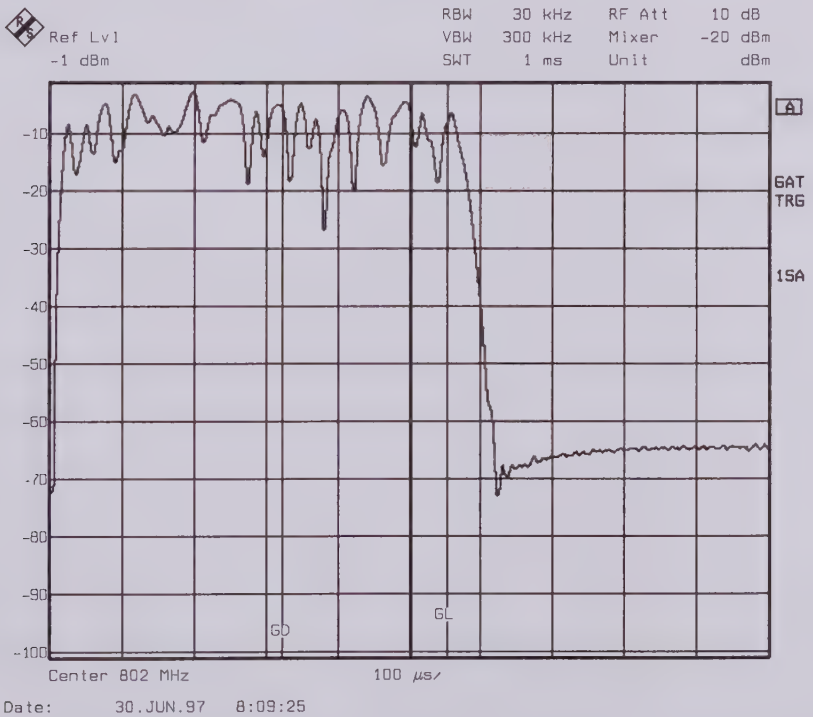


Fig. 4-16 Setting the GATE DELAY and GATE LENGTH times in the time domain using the GD and GL lines

On quitting the menu *GATE ADJUST*, the ESI returns to spectral representation.

Sweep Blanking – Gap Sweep

For measurements in the time domain, the *GAP SWEEP* function offers a high degree of flexibility with regard to the display of measurement data. With the *PRE TRIGGER* softkey, it is possible to display measurements taken before the trigger time. With the *GAP TIME* softkey, the measurements within a predefined time range can be blanked. Thus, it is possible to display the rising and falling edge of a signal with high resolution on a single diagram.

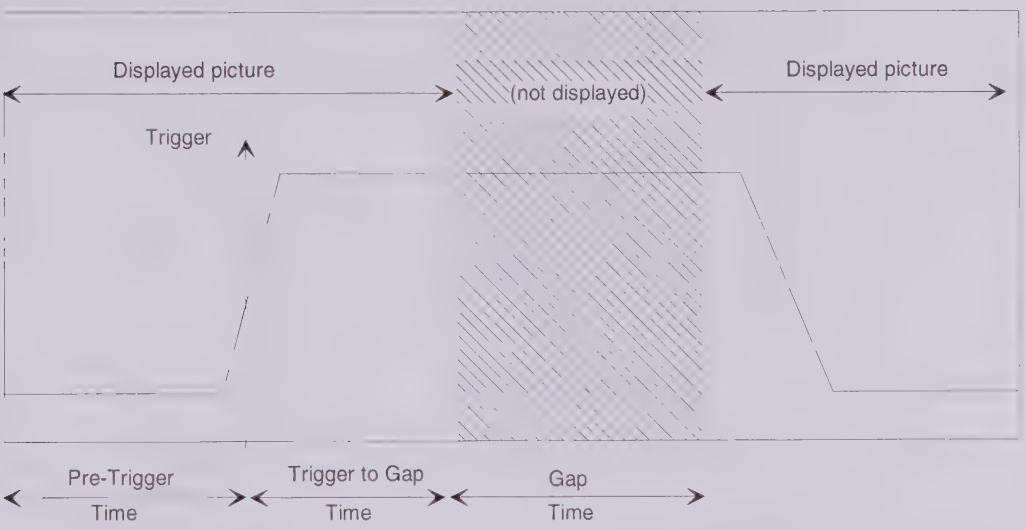


Fig 4-17 Trace blanking in sweep mode.– Gap Sweep

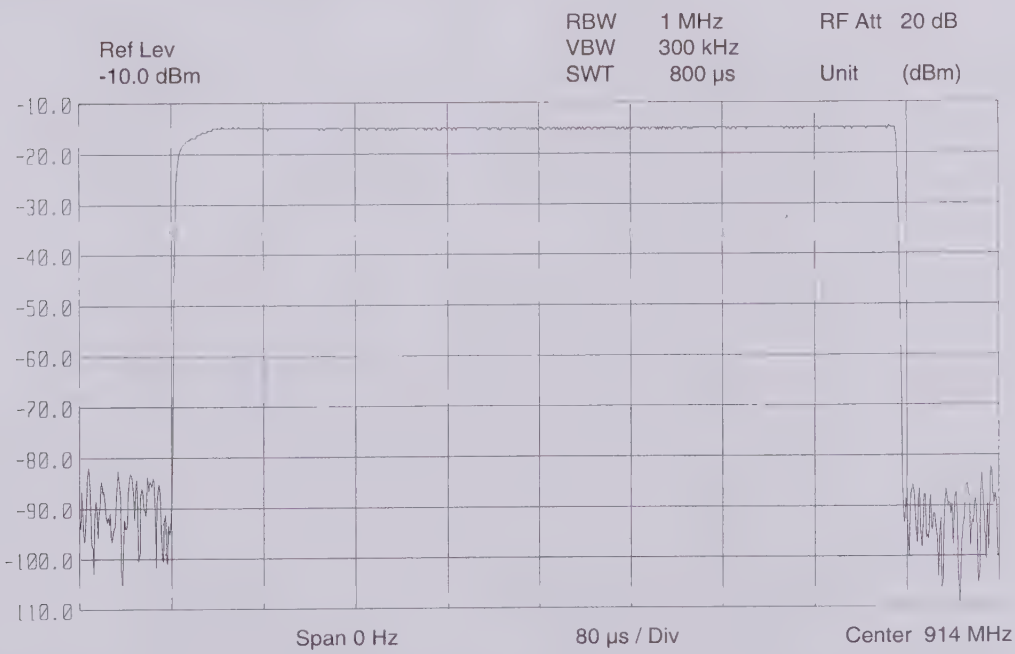


Fig. 4-18 Display of a burst without gaps

Fig. 4-19 Display of a burst with a gap

The *GAP SWEEP* measurement is activated by the *GAP SWEEP ON/OFF* softkey. The mode settings are made in the *GAP SWEEP SETTINGS* sub-menu.

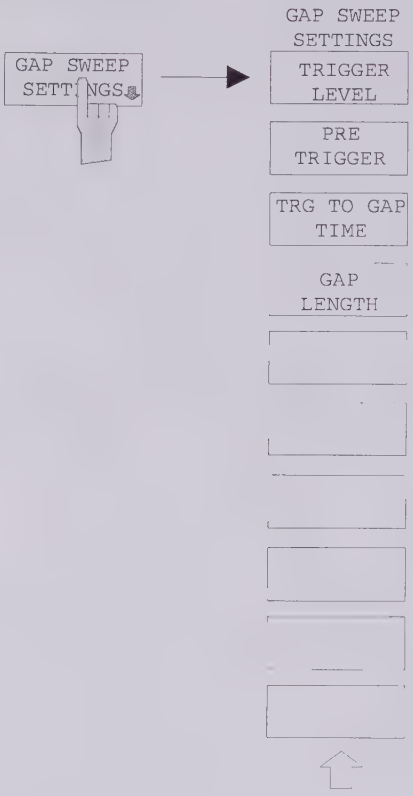
SWEEP SWEEP menu:

The *GAP SWEEP ON/OFF* softkey switches the *GAP SWEEP* measurement on/off.

The softkey is available only in the time domain.

IEC/IEEE-bus command `:[SENSe<1|2>:]SWEep:GAP ON | OFF`

SWEEP SWEEP-GAP SWEEP SETTINGS sub-menu:



The *GAP SWEEP SETTINGS* softkey opens a sub-menu in which the parameters for the gap can be selected.

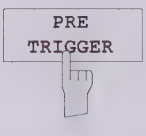
The trigger time corresponds to t = 0. Events occurring before the trigger time are displayed in negative time.

The *TRIGGER LEVEL* softkey activates the entry window for trigger level.

This function corresponds to the setting in the trigger menu.

IEC/IEEE-bus command

```
:TRIGger<1|2>[:SEQuence]:LEVel:VIDeo 50PCT
```



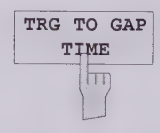
The *PRE TRIGGER* softkey activates the entry window for the pre-trigger time. The pre-trigger time defines the separation between the left edge of the grid and the trigger time (t = 0).
At the same time the gap sweep is switched on (exception : entry t = 0)

The minimum pre-trigger time is –100 s, the maximum pre-trigger time depends on the sweep time and the trigger to gap time (max = 100 s). The maximum resolution is 50 ns.

The *PRE TRIGGER* value can be entered in the frequency domain (span > 0) as well as in the time domain and *GAP SWEEP OFF* mode. It is, however, only effective when the *GAP SWEEP* measurement is enabled.

IEC/IEEE-bus command

```
:SENSe<1|2>:]SWEep:GAP:PRETrigger 100us
```



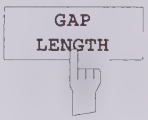
The *TRG TO GAP TIME* softkey opens an entry window for defining the distance between the trigger time and the beginning of the gap.

The *TRIGGER TO GAP TIME* range is from 0 to 100 s with a resolution of 50 ns. The length of the gap is defined by *GAP LENGTH*. If the *GAP LENGTH* is 0 s, the entered value of *TRG TO GAP TIME* is only stored.

The *TRG TO GAP TIME* value can be entered in the frequency domain (span > 0) as well as in the time domain and for the *GAP SWEEP OFF* mode. It has an effect on the measurement only after the *GAP SWEEP ON* is switched on.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]SWEep:GAP:TRGTogap 50us
```



The *GAP LENGTH* softkey activates the entry window for defining the gap within which the measurement values are to be blanked.

The beginning of the gap is defined by *TRG TO GAP TIME*.

GAP LENGTH can be set to values between 150 ns and 100 s in 1/2/3/5 steps. The resolution is dependent upon the absolute value of the gap length:

Gap length	Resolution
150 ns - 50 µs	50 ns
50 - 500 µs	500 ns
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

The *GAP LENGTH* value can be entered in the frequency domain (span > 0) as well as in the time domain and for the *GAP SWEEP OFF* mode. It has an effect on the measurement only after the *GAP SWEEP ON* is switched on.

IEC/IEEE-bus command

```
:[SENSe<1|2>:]SWEep:GAP:LENGth 400us
```

Tracking Generator Option

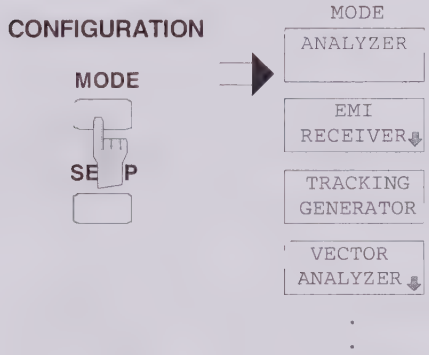
In the normal mode, the tracking generator sends a signal exactly at the input frequency of the instrument without a frequency offset.

For frequency-converting measurements it is possible to set a constant frequency offset of ±200 MHz between the output signal of the tracking generator and the receive frequency of the instrument.
Also, two analog input signals can be used to I/Q or AM and BB-FM modulate the output signal (option FSE-B11).

The output level is level-controlled and can be set from -20 to 0 dBm in 0.1-dB steps The level control can also be operated with external detectors. When the tracking generator is equipped with the optional attenuator, the setting range is extended from -90 dBm to 0 dBm.

The tracking generator can be used in all operating modes. The recording of test setup calibration values (SOURCE CAL) and the normalization with this correction values (*NORMALIZE*) is only possible in operating mode *ANALYZER MODE*.

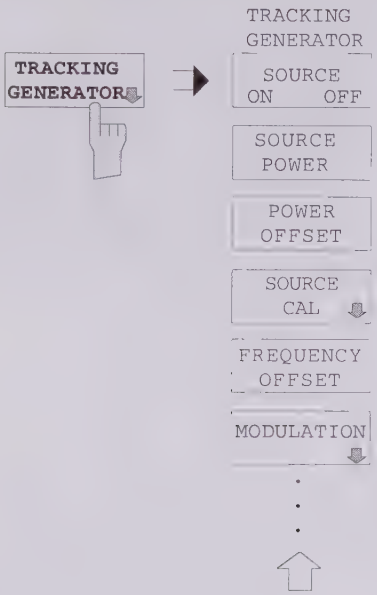
SYSTEM MODE menu:



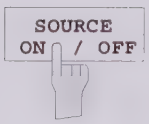
The *MODE* key activates the menu in which the submenu for setting the tracking generator can be selected in addition to different operating modes.

Tracking Generator Settings

SYSTEM MODE menu:

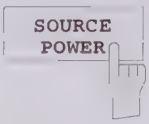


The *TRACKING GENERATOR* softkey opens a menu for setting the functions of the tracking generator.



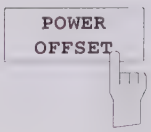
The *SOURCE ON/OFF* softkey switches the tracking generator on or off.
Default setting is *OFF*

IEC/IEEE bus command `:OUTPut[:STATe] ON | OFF`



The *SOURCE POWER* softkey activates the entry of the tracking generator output level.
The output level can be set from 0 dBm to -20 dBm in 0.1-dB steps. The setting range is extended to -90 dBm when the tracking generator is equipped with the optional attenuator FSE-B12.
If the tracking generator is off, it is automatically switched on by the *SOURCE PWR* softkey.
Default setting is -20 dBm.

IEC/IEEE bus command
`:SOURce:POWer[:LEVel][:IMMediate][:AMPLitude] <num_value>`



The *POWER OFFSET* softkey activates the entry of a constant level offset of the tracking generator.
With this offset it is possible to consider attenuators or amplifiers at the output connector of the tracking generator during the input or output of output levels, for example.
The permissible setting range is -200 dB to +200 dB in 0.1-dB steps. Positive offsets apply to a subsequent amplifier and negative offsets to an attenuator.
Default setting is 0 dB.

IEC/IEEE bus command
`:SOURce:POWer[:LEVel][:IMMediate]:OFFSet <num_value>`

Transmission Measurement

In this measurement, the transmission characteristic of a two-port network is measured. The built-in tracking generator is the a signal source. The tracking generator is connected to the input of the DUT. The input of the instrument is connected to the output of the DUT.

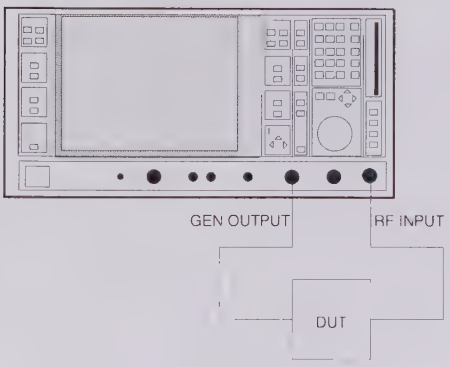
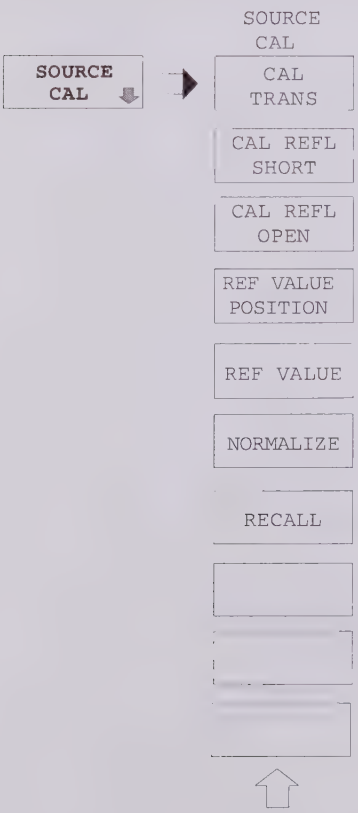


Fig. 4-20 Test setup for reflection measurements

Calibration can be carried out to allow for the effects from the test setup (eg. frequency response of connecting cables).

Calibration of the Transmission Measurement

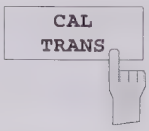
SYSTEM MODE-TRACKING GENERATOR menu:



The *SOURCE CAL softkey* opens a submenu with the calibration functions for transmission and reflection measurements.

The calibration for the reflection measurement is described of the following sections .

To carrry out a calibration for transmission measurements the whole test setup is through-connected (THRU).



The *CAL TRANS* softkey triggers the calibration for the transmission measurement.

It starts a sweep that records a reference curve. This trace is then used to obtain the differences to the normalized values.

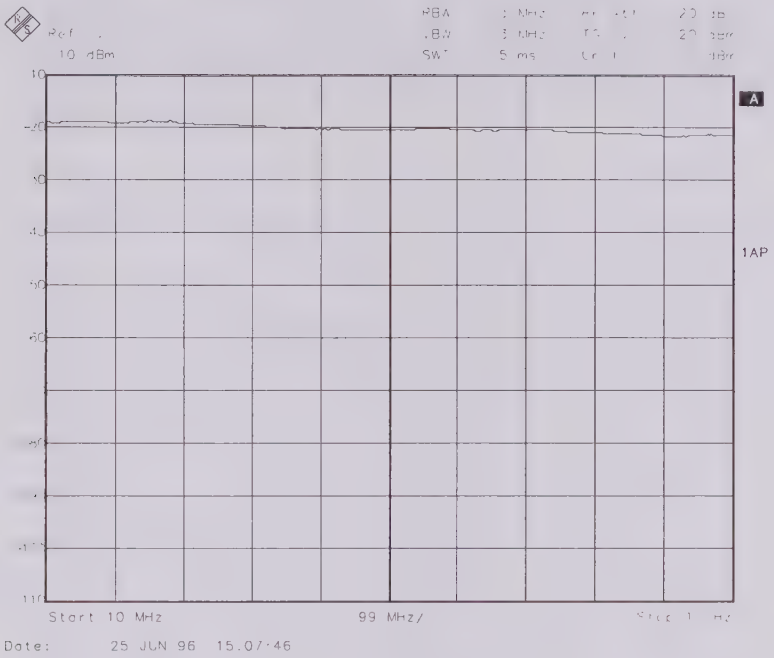
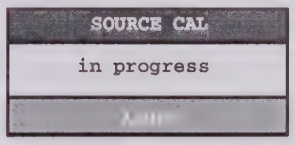
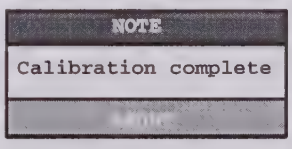


Fig. 4-21 Trace of a transmission calibration procedure

During the calibration sweep the following message is displayed:



After the calibration sweep the following message is displayed:



This message is cleared after approx. 3 seconds.

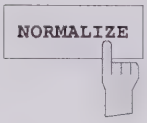
By saving and recalling the reference data set with the *SAVE* and *RECALL* keys, several calibration datasets can be saved and, then, if necessary, any of these sets can be selected without going through a new calibration routine.

IEC/IEEE bus command

```
:[SENSe:]CORRection:METHod TRANsmission
:[SENSe:]CORRection:COLLect[:ACQuire] THRough
```

Normalization

SYSTEM MODE-TRACKING GENERATOR -SOURCE CAL menu:



The *NORMALIZE* softkey switches the normalization on or off. The softkey is only enabled if the memory contains a correction trace.

If no reference line is switched on when activating the normalization, all measured values are with reference to the top grid line. The effects of the test setup is corrected in such a way that the measured values are displayed at the top grid margin.

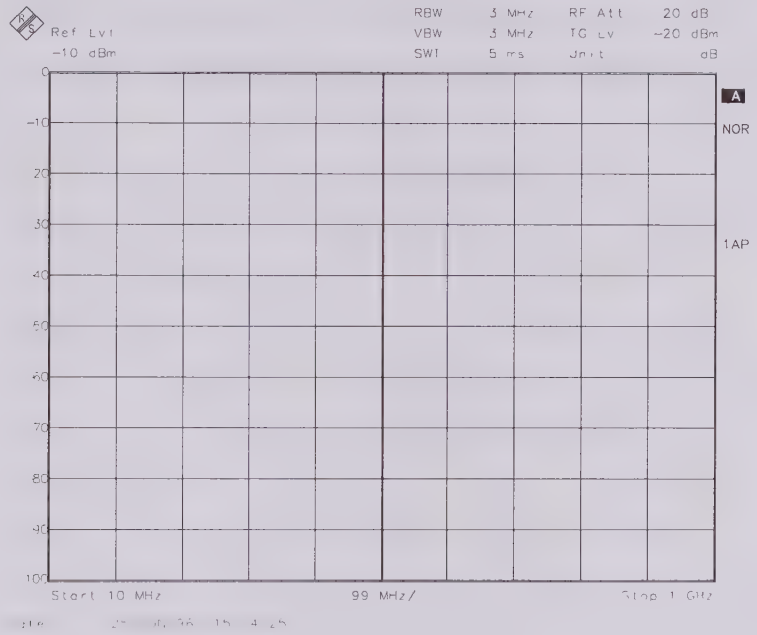


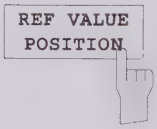
Fig. 4-22 Normalized display

In *SPLIT SCREEN* mode, normalization is switched on in the currently active screen. Different types of normalization can be activated in the two split screens.

Normalization is aborted when the *ANALYZER* operating mode is quit but can be switched on again as long as the reference trace stored in the memory has not been overwritten.

IEC/IEEE bus command `:[SENSe:]CORRection[:STATe] ON | OFF`

It is now possible to shift the relative reference point within the grid by using the *REF VALUE POSITION* softkey. This means that the trace can be shifted from the upper edge of the grid towards the center of the grid:



The *REF VALUE POSITION* softkey (reference position) marks a reference position in the active screen at which normalization is performed (difference between trace and reference trace).

If no reference line is switched on, the softkey switches on a reference line and activates the input of its position. The line can be moved within the grid limits.
The reference line is switched off by pressing the softkey again.

The function of the reference line is explained in section "Calibration Method"

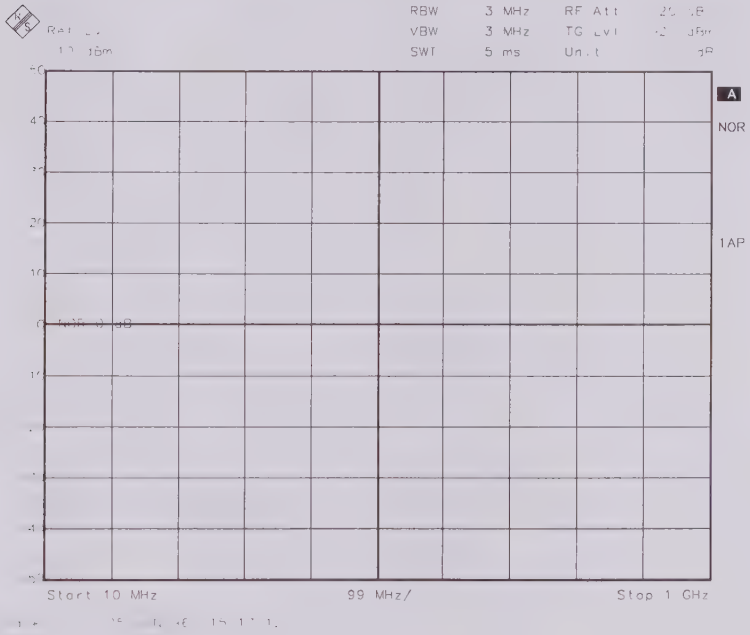


Fig. 4-23 Normalized measurement, shifted with *REF POSITION* 50 %

IEC/IEEE bus command

```
:DISPlay[:WINDow<1|2>]:TRACe<1..4>:Y[:SCALe]:RPOSition
                                                0 to 100PCT
```

The *REF VALUE* softkey activates the entry of a level difference which is assigned to the reference line.

With normalization switched on, all measured values are displayed relative to the reference line, or if the latter is switched off relative to the top grid line which corresponds to 0 dB with default setting.

REF VALUE always refers to the ative screen.

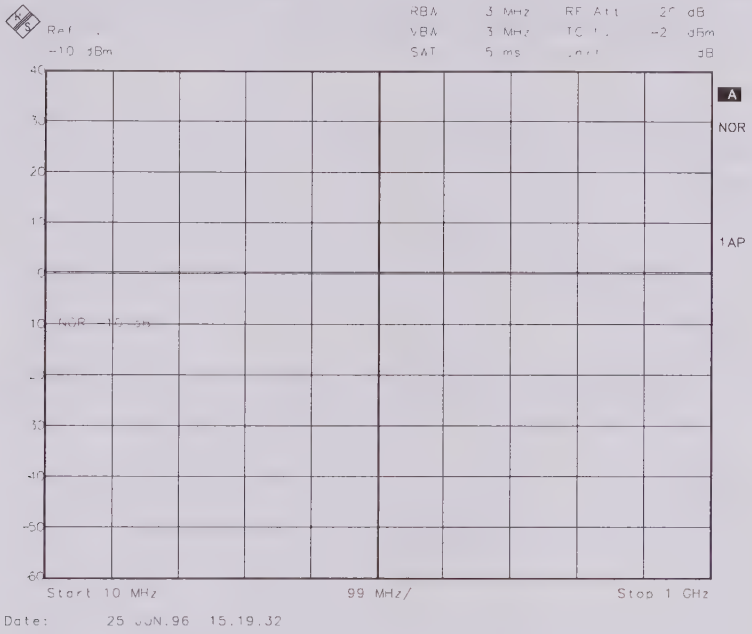


Fig. 4-24 Measurement with REF VALUE 20 dB and REF VALUE POSITION 50%

If, after source calibration, a 10 dB attenuator is inserted into the signal path between DUT and analyzer input, the measurement trace will be moved down by 10 dB. Entering a *REF VALUE* of –10 dB then moves the reference line down 10 dB. This means that the measured trace and the reference trace coincide again.
After the reference line has been moved by entering a *REF VALUE* of –10 dB, deviations from the nominal power level can then be displayed with a high resolution (e.g. 1 dB/div). The power is still displayed in absolute values, which means that in the above example 1 dB below the nominal power (reference line) is equivalent to an attenuation of 11 dB.

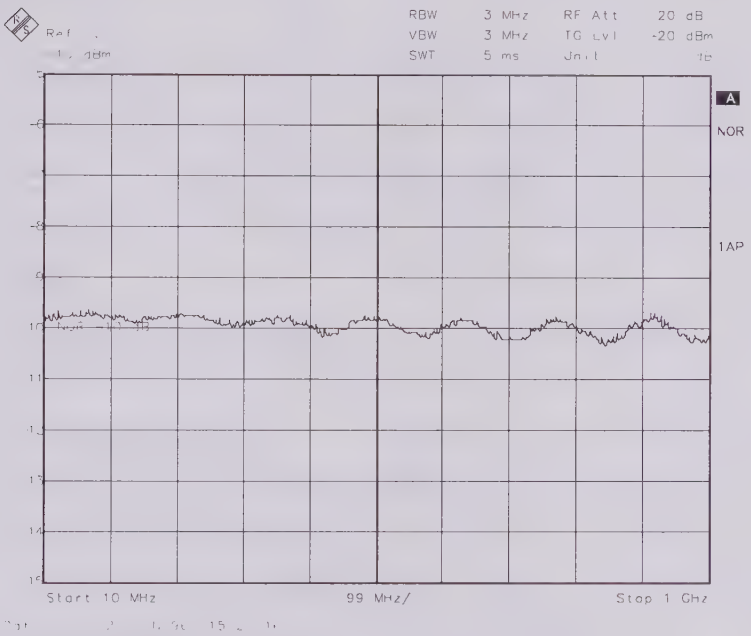
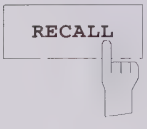


Fig. 4-25 Measurement of a 10dB attenuator pad with 1 dB / Div

IEC/IEEE bus command
`:DISPlay[:WINDow<1|2>]:TRACe<1...4>:Y[:SCALe]:RVALue <num_value>`



The *RECALL* softkey restores the instrument setting that were used during calibration.
This can be useful if the device setting was changed after calibration (eg center frequency setting, frequency deviation, reference level, etc.).

The softkey is only offered if:
- the analyzer mode has been selected
- the memory contains a calibration data set.

IEC/IEEE bus command `:[SENSe:]CORRection:RECall`

Reflection Measurements

Scalar reflection measurements can be carried out with a reflection-coefficient bridge.

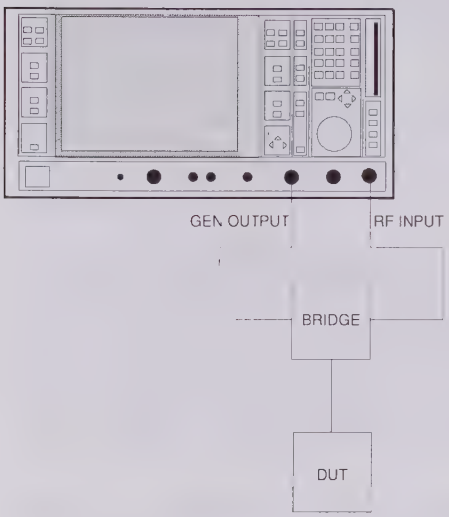


Fig. 4-26 Test setup for reflection measurements

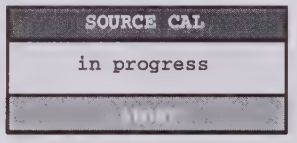
Calibration of Reflection Measurement

This calibration procedure essentially corresponds to that of the transmission measurement.

SYSTEM MODE-TRACKING-SOURCE CAL submenu

The *CAL REFL OPEN* softkey starts the open-circuit calibration.

During calibration the following message is displayed



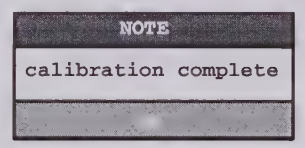
IEC/IEEE bus command

```
:[SENSe:]CORRection:METHod REFLexion
:[SENSe:]CORRection:COLLect[:ACQuire] OPEN
```

The *CAL REFL SHORT* softkey starts the short-circuit calibration.

If both calibrations (open circuit, short circuit) are carried out, the calibration curve is formed by averaging the two measurements and is stored in the memory. The order of measurements is optional.

The completion of the calibration is indicated by



The display is cleared after 3 seconds.

IEC/IEEE bus command

```
:[SENSe:]CORRection:METHod REFLexion
:[SENSe:]CORRection:COLLect[:ACQuire] THRough
```

Calibration Methods

Calibration means forming the difference between current measured values and a reference curve, no matter what the selected measurement type is (transmission/reflection). The hardware settings used for measuring the reference curve are included in the reference dataset.

When normalization is switched on, a wide range of device settings can be changed without aborting normalization. In other words, the number of repeat normalizations is kept to a minimum.

The reference dataset (trace with 500 measured values) is stored internally as a table of 500 points (frequency/level).

Differences in level settings between the reference curve and the current device setting are calculated automatically. For small spans, a linear interpolation is used. If the span is increased, , the values at the left or right border of the reference dataset are extrapolated out to the new start or stop frequency; in other words, additional linearly extrapolated values are added to the reference dataset.
An enhancement label is used to mark the different levels of measurement accuracy. This enhancement label is displayed at the right display margin when normalization is switched on and in case of an error from the reference setting. Three accuracy levels are defined:

Table 4-1 Measurement accuracy levels

Accuracy	Enhancement label	Reason/Limitation
High	NOR	No difference between reference setting and measurement
Medium	APP (approximation)	Changes in the following settings: ■ coupling (RBW, VBW, SWT) ■ reference level, RF attenuation ■ start or stop frequency ■ output level of tracking generator ■ frequency offset of tracking generator ■ detector (max peak, min peak, sample...) Change of frequency: ■ at most 500 frozen continuation points within the set sweep limits (corresponds to a doubling of the span)
-	Abortion of calibration	■ more than 500 frozen points within the set sweep limits (span doubling)

Note: *At a reference level (REF LEVEL) of -10 dBm and at a tracking generator output level of the same value the instrument operates without a headroom. ie the instrument is in danger of being overloaded by any signal whose amplitude exeeds the reference line. In this case, either the message "OVLD" for overload is displayed in the status line or the display range is exceeded (clipping the top of the trace = Overrange).*

This overload can be avoided as follows:

- *Reducing the output level of the tracking generator (SOURCE POWER, SYSTEM-MODE-TRACKING GENERATOR menu)*
- *Increasing the reference level (REF LEVEL, LEVEL-REF menu)*

Frequency-Converting Measurements

For frequency-converting measurements (eg on converters) the tracking generator is able to set a constant frequency offset between the output frequency of the tracking generator and the receive frequency of the instrument. Up to an output frequency of 200 MHz the measurement can be carried out in inverted and normal position.

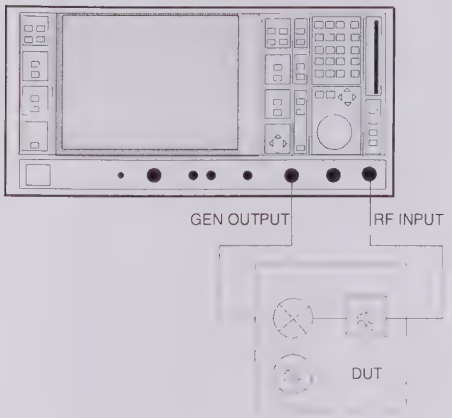


Fig. 4-27 Test setup for frequency-converting measurements

SYSTEM MODE-TRACKING GENERATOR menu:

The *FREQUENCY OFFSET* softkey activates the entry of the frequency offset between the output frequency of the tracking generator and the input frequency of the instrument. The setting range is ±200 MHz in 1-Hz steps. The default setting is 0 Hz.

If a positive frequency offset is entered, the tracking generator generates an output signal frequency above the receive frequency of the instrument. With a negative frequency offset it generates a signal frequency below the receive frequency of the instrument. The output frequency of the tracking generator is calculated as follows:

Tracking generator frequency = receive frequency + frequency offset.

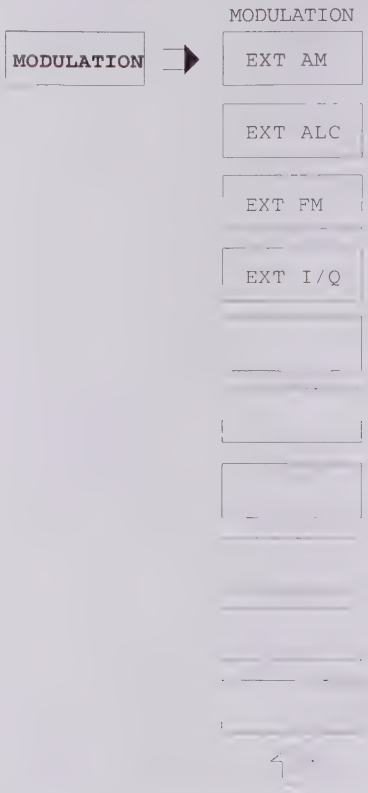
A frequency offset cannot be entered if an external I/Q or FM modulation is switched on. In this case, the *FREQUENCY OFFSET* softkey is blocked.

IEC/IEEE bus command

```
:SOURce:FREQuency:OFFSet <numeric value>
```

External Modulation of Tracking Generator

SYSTEM MODE-TRACKING GENERATOR menu:



The *MODULATION* softkey opens a submenu for selecting the different modulation types.

The time characteristic of the output signal of the tracking generator can be varied by applying external signals (input voltage range -1 V to +1 V).

The functions for amplitude and frequency modulation and for external level control are always available.

The function IQ modulation is only available in model FSE-B11 of the tracking generator that is equipped with the IQ modulator.

Two BNC connectors at the rear panel are available as signal inputs. Their function changes depending on selected modulation type:

TG-INPUT I / AM / ALC and

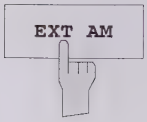
TG-INPUT Q / FM

The types of modulation can partly be combined with each other and with the frequency offset function. The following table shows which modulation types can be selected simultaneously and which can be combined with the frequency offset function.

Table 4-2 Simultaneous modulation types (tracking generator)

Modulation	Frequency offset	EXT AM	EXT ALC	EXT FM	EXT I/Q
Frequency offset		—	—	—	
EXT AM	▪			▪	
EXT ALC	▪				
EXT FM	—	—			
EXT I/Q					

▪ modulations can be combined



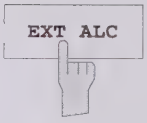
The *EXT AM* softkey activates AM modulation of the tracking generator output signal.

The modulation signal is connected to the *TG-INPUT AM* connector. The maximum possible modulation depth is 80% which corresponds to an input voltage of 0.8 V.

Switching on external AM deactivates the following functions:

- active external level control
- active I/Q modulation.

IEC/IEEE bus command `:SOURce:AM:STATe ON | OFF`



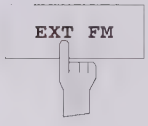
The *EXT ALC* softkey activates the external level control.

In case of external level control the output level of the tracking generator is determined from the signal of an external detector. The external detector has to supply a negative voltage in the range of -0.1 to -1 V which is applied to the *TG-INPUT ALC* connector. The setting of the output level is the same as that of the internal level control but the output level depends on the external detector.

Switching on an external level control deactivates the following functions:

- active external AM
- active I/Q modulation.

IEC/IEEE bus command `:SOURce:POWer:ALC:SOURce INT | EXT`



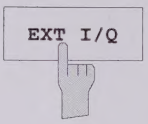
The *EXT FM* softkey activates FM modulation of the tracking generator output signal.

The modulation frequency range is 1 kHz to 100 kHz, the deviation is approx. 1 MHz at an input voltage of 1 V.
The modulation signal is connected to the TG-INPUT FM connector.

Switching on external FM deactivates the following function:

- active I/Q modulation.

IEC/IEEE bus command `:SOURce:FM:STATe ON | OFF`



The *EXT I/Q* softkey is only offered with I/Q modulator option built-in. It activates external I/Q modulation of the tracking generator (FSE B-11).

The modulation signals are connected to the two input connectors *TG-INPUT IN* and *TG-INPUT Q* at the rear of the unit. The input voltage range is ±1 V into 50 ■.

Switching on external I/Q modulation deactivates the following functions:

- active external AM
- active external level control
- active external FM or
- a level offset.

Functional description of quadrature modulator:

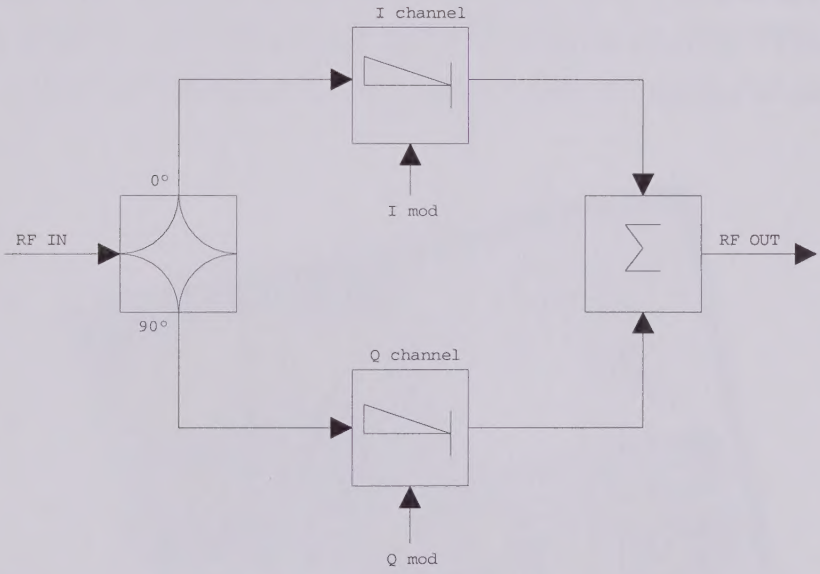


Fig. 4-28 I/Q modulation

I/Q modulation is performed by means of the built-in quadrature modulator. The RF signal is divided into the two orthogonal components, I and Q (inphase and quadrature phase). Amplitude and phase are controlled in each path by the I and Q modulation signal. Adding the two components generates an RF output signal whose amplitude and phase can be controlled.

IEC/IEEE bus command `:SOURce:DM:STATe ON | OFF`